

**BETWEEN KNOWLEDGE
AND PRACTICES: AN
INTERVIEW WITH
PROFESSOR DR.
GILVANDENYS LEITE SALES**

**ENTRE SABERES E PRÁTICAS: UMA ENTREVISTA COM O PROFESSOR DR.
GILVANDENYS LEITE SALES**

Ciências Exatas e da Terra, Ciências Humanas • 20/05/2026

REGISTRO DOI: [10.70773/revistatopicos/779213742](https://doi.org/10.70773/revistatopicos/779213742)

Antonio Rodrigo dos Santos Silva¹

Gilvandenys Leite Sales²

José Marques Soares³

ABSTRACT

This text presents an interview conducted with Professor Dr. Gilvandenys Leite Sales, a faculty member at the Federal Institute of Education, Science and Technology of Ceará. With more than 35 years dedicated to teaching Physics, he stands out for his research trajectory, having supervised dozens of academic works throughout his career and developed innovative proposals, such as Learning Vectors Model, aimed at assessment in Distance Education within the Help Class Virtual Learning Environment, recognized as the best thesis in the field of Computer Science in Education by the Brazilian Computer Society in 2011. Even after retirement, he maintains continuous academic activity and scientific output, working in the Postgraduate Program in Teaching of the Northeast Teaching Network (RENOEN), with research on topics such as the Methodological Cognitive Apprehension Procedure (6C/PCMA), Learning Vectors (LV), teaching planning using 5W2H, and active methodologies.

Keywords: Teaching; Physics; Sciences; Learning Vectors; Didactic Sequence.

RESUMO

Este texto apresenta uma entrevista realizada com o professor Dr. Gilvandenys Leite Sales, docente do Instituto Federal de Educação, Ciência e Tecnologia do Ceará. Com mais de 35 anos dedicados ao magistério no ensino de Física, destaca-se por sua trajetória na pesquisa, orientando dezenas de trabalhos ao longo de sua carreira e desenvolvendo propostas inovadoras, como o Modelo Learning Vectors, voltado à avaliação em Educação a Distância no Ambiente Virtual de Aprendizagem Help Class, reconhecida como a melhor tese na área de Informática na Educação pela Sociedade Brasileira de Computação em 2011. Mesmo após a aposentadoria, mantém

atuação acadêmica e produção científica contínua, atuando no Programa de Pós-Graduação em Ensino da Rede Nordeste de Ensino (RENOEN), com investigações em temas como o Procedimento Cognitivo Metodológico de Apreensão (6C/PCMA), Learning Vectors (LV), planejamento de ensino usando 5W2H e metodologias ativas.

Palavras-chave: Ensino; Física; Ciências; Learning Vectors; Sequência Didática.

1. INTRODUCTION

Education in Brazil has become the subject of growing academic debate in recent decades, especially in light of the challenges posed by an educational system marked by structural inequalities, gaps in teacher training, and precarious working conditions, such as the lack of laboratories, shortage of teaching materials, teacher overload, and low salaries (Belíssimo; Nardi, 2026). This issue is further aggravated by the historically established disconnect between university scientific production and the everyday reality of basic education classrooms (Paixão, 2026), a situation that undermines the quality, diversity, and innovation of student education.

In this context, understanding the trajectories of educators who made significant contributions to teaching is not only an exercise in academic memory, but also an opportunity for critical reflection on pedagogical practice, since, as Paulo Freire states, “teaching requires critical reflection on practice” (Freire, 2025, p. 37, our translation). Thus, by analyzing the experiences, methodologies, and perspectives developed by educators throughout their careers, it becomes possible to inspire new generations of teachers and researchers, as well as to foster structural and educational changes

aimed at more meaningful, authentic, and student-centered learning.

We agree with Santos (2025) that teaching work goes beyond mastering specific content, requiring teachers to possess reflective capacity, critical analysis of the school reality, adaptability to different teaching situations, and a continuous commitment to improving pedagogical practice. Levinson *et al.* (2024) argues that science teacher education should promote critical thinking, democratic participation, and the articulation between scientific knowledge and social realities, encouraging teachers and students to engage with socio-scientific controversies, dialogue, and inquiry-based learning. This articulation becomes even more complex when considering contemporary spatiotemporal structures, characterized by their dynamic, inclusive, active, and technological nature, demanding that educators reflect on the kind of training needed and on what type of professional and educational institution we want for the future (Imbernón, 2022).

Distance Education (DE) and the use of Virtual Learning Environments (VLEs) have increasingly become important digital pedagogical frameworks for supporting science education, as they enable the use of interactive and multimedia resources that promote meaningful learning, the development of scientific concepts, and greater student engagement in the educational process (Silva; Almeida; Veloso, 2021). At the same time, the incorporation of theoretical perspectives such as Vigotski's historical-cultural theory (Vigotski, 2007) and Feuerstein's theory of Structural Cognitive Modifiability (Feuerstein *et al.*, 2023) has contributed to the development of approaches that are more responsive to learner

diversity and to contexts marked by educational vulnerability (Arantes, 2023; Silva; Sales; Soares, 2026).

In this context, investigating the experiences and reflections of educators with significant academic and professional trajectories becomes a relevant way to understand how Science Teaching has been conducted over time. From this perspective, the study is guided by the following research question:

How do the academic and professional experiences of Professor Dr. Gilvandenys Leite Sales contribute to understanding the paths, challenges, and transformations of Science Teaching throughout his career trajectory?

The general objective of this study is to present, through an interview, the theoretical, methodological, and practical contributions of Professor Dr. Gilvandenys Leite Sales (Figure 1) to Science Education. The specific objectives are: (i) to list the main pedagogical models and tools developed by the interviewee throughout his career trajectory; (ii) to identify the theoretical foundations that support his teaching practice and scientific production; (iii) to present the interviewee's perspective on the challenges and future perspectives of Science Teaching.

Figure 1 - Professor Dr. Gilvandenys Leite Sales



Source: interviewee's personal collection

The relevance of this research is justified across multiple dimensions. From a theoretical perspective, it contributes to the mapping of innovative pedagogical approaches applied to Science Teaching, especially those that articulate technology, formative assessment, and theories of human development. From a practical perspective, it offers support for pre-service and in-service teachers seeking consolidated references to rethink their teaching practices.

2. MATERIALS AND METHODS

The present research is characterized as a qualitative study, using the focused interview as the main methodological instrument, supported by a quantitative study to validate the interview questions. According to Taherdoost (2026), qualitative data collection seeks to understand and interpret the meanings individuals give to their experiences and social realities. Unlike quantitative research, which is based on numerical data, qualitative research focuses on participants' perspectives and experiences through methods such as interviews and observations.

As part of the research procedures, the interviewee used a memorial document to support their narratives and reflections, which gives the investigation autobiographical and documentary research elements.

The interview was conducted between 2025 and 2026 and took place both in person at the LHAMA Laboratory at the Federal Institute of Education, Science and Technology of Ceará and virtually, depending on the interviewee's availability. This period was necessary for the planning of the interview guide, the establishment of an initial rapport, the collection of accurate and reflective responses, and the identification of relevant documents throughout the research process. Google Docs was used to support the recording and organization of the interview. The interview was conducted in an structured manner, with the use of a fixed script of previously established questions (Gil, 2026).

The interview script was collaboratively developed, which enabled the identification and exclusion of questions with limited analytical potential, thereby ensuring greater objectivity and methodological consistency of the instrument. A total of seven questions were retained and organized into thematic blocks aligned with the study objectives, ensuring a balanced distribution of topics without making the script excessively long or overly concise.

Before its application, the instrument underwent a two-round validation process using the Vali-Quali methodology proposed by Torlig *et al.* (2022). In each round, the interview questions were evaluated by four judges, consisting of two anonymous human evaluators and two large language model (LLM)-based artificial intelligence systems, namely Claude and ChatGPT. The evaluation

considered two analytical dimensions: (i) the content dimension, which assesses the alignment of the questions with the research objectives and their adherence to the investigated constructs, and (ii) the semantic dimension, which examines the clarity of language and the qualitative expectations associated with the responses sought.

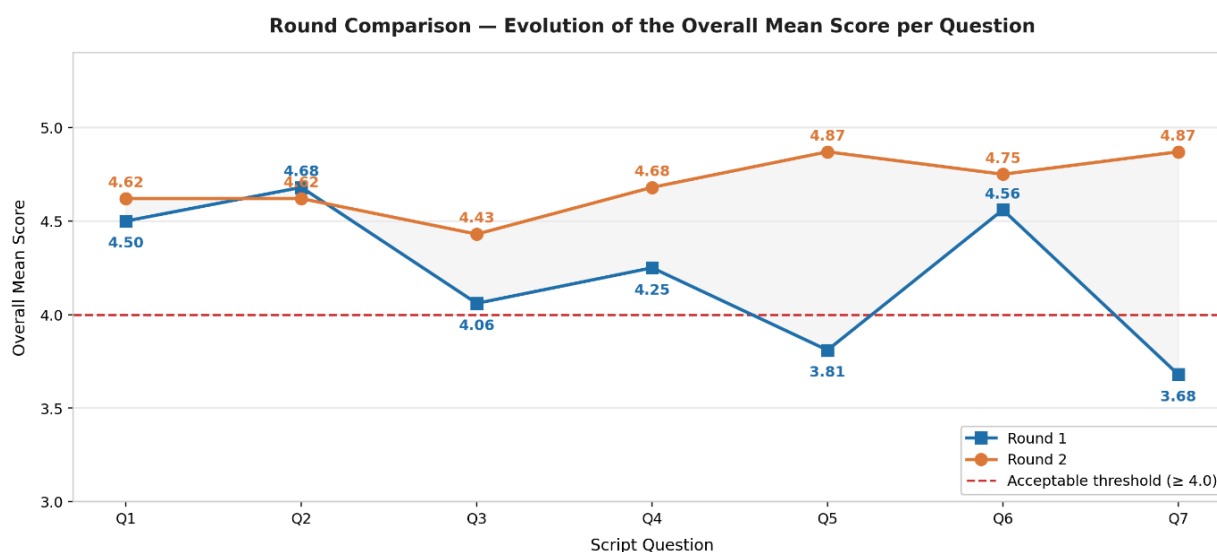
Each attribute of the interview script was rated on a five-point scale, corresponding respectively to no (1), low (2), moderate (3), high (4), and complete degree of adequacy (5). Based on these scores, the questions were classified according to predefined acceptance thresholds: full approval (mean score equal to 5.0), optional modification (mean score between 4.5 and 5.0), required modification (mean score between 2.5 and 4.5), and exclusion (mean score between 1.0 and 2.5).

In the first validation round, the instrument achieved an overall mean score of 4.22, indicating that most questions required either optional or necessary modifications. Specifically, Questions 1, 2, and 6 were classified as requiring optional modification, with mean scores of 4.50, 4.68, and 4.56, respectively. In contrast, Questions 3, 4, 5, and 7 were classified as requiring modification, obtaining mean scores of 4.06, 4.25, 3.81, and 3.68. Based on the evaluators' comments and recommendations, revisions were implemented to improve semantic clarity, wording precision, and adherence to the investigated constructs.

Following these revisions, a second validation round was conducted to reassess the adequacy of the modified instrument. The results demonstrated a substantial improvement in the evaluative scores (Figure 2), with the overall mean increasing to 4.69. In this stage, six

of the seven questions were classified as requiring only optional modification, while one question remained in the “required modification” category. Questions 5 and 7 showed the most expressive improvement, rising from 3.81 and 3.68 to 4.87, respectively. These findings indicate that the iterative validation process contributed significantly to enhancing the clarity, coherence, and methodological adequacy of the final interview script, supporting its suitability for data collection purposes.

Figure 2 - Evolution of the overall average by question



Source: authors (2026).

3. THE INTERVIEW

Interviewer (I): Professor Sales, thank you for your participation. Could you tell us about your academic and professional journey, highlighting the key moments and experiences that most influenced your involvement in Science Teaching?

Professor Sales (PS): My journey began in a public school. I am the son of humble, hardworking parents and believed, from an early age, that education was the only possible path. I attended a primary school called Estado do Pará, in the Aerolândia neighborhood, then

the Noel Huguen School, in Tauape, and eventually reached the Federal Technical School of Ceará (the beloved ETFCE), where I graduated as a Technical Assistant in Electrotechnics in 1976. All within Fortaleza city.

In 1980, at 19 years old, I completed the Aerial Photogrammetry course at the School of Aeronautics Specialists, placing 5th in the selection process. I then served for ten years as a photographer. In 1988, I left the military to pursue a career in education — first in the public school system of Pernambuco. The following year, I ranked 1st in the first civil service examination for Physics teachers held at the Federal Technical School of Pernambuco (following the new Constitution) and took up my position in 1990 as part of the federal education network.

My undergraduate degree was in Physics: a teaching licensure completed at the Catholic University of Pernambuco (UNICAP) in 1987, where I graduated with the highest grade in my class. In 1989, I completed a Specialization in Higher Education Methodology, also at UNICAP. Later, already in Ceará, I pursued a professional master's degree in Computing with a focus on Educational Technology at the State University of Ceará (UECE) in 2003, where I developed the "Quantum Duck": a simulation for the photoelectric effect. That work led to a publication in the Brazilian Journal of Physics Teaching (Sales *et al.*, 2008). My doctoral degree followed at the Department of Teleinformatics Engineering at the Federal University of Ceará: after five grueling attempts to get in! I was finally admitted in 1st place and successfully defended my dissertation in 2010.

My academic journey has always been driven by a desire to keep learning and growing. In 2021, I went to Portugal to complete a

postdoctoral fellowship in Educational Technologies at the University of Minho. I then pursued a bachelor's degree in Food Engineering at the Federal University of Ceará (UFC), which I completed in 2023. During that period, I had the opportunity to gain international experience at the École d'Ingénieurs de PURPAN in Toulouse, France, working with ozonization processes applied to red fruits as a CAPES scholarship recipient through the BRAFAGRI program. I also completed a degree in Nutrition at UNINASSAU in 2024 and hold an active registration with the Regional Nutrition Council (CRN11). I am currently continuing my professional development through specializations in Functional Clinical Nutrition at Faculdade VP, and in Phytotherapy at FAVENI. I now work as a Nutritionist (a field I find incredibly fascinating and fulfilling) while still teaching and supervising doctoral students in Science Teaching at RENOEN-IFCE (the Northeast Teaching Network of the Federal Institute of Education, Science and Technology of Ceará).

I: What do you consider your most significant contributions to Science Teaching practice?

PS: Well... One of them was the Learning Vectors (LV) Model, developed during my doctoral dissertation (Sales, 2010). It is a methodology and formative assessment tool for virtual learning environments, capable of monitoring student learning in distance education courses in a non-linear way. It was recognized in 2011 by the Brazilian Computer Society as the best thesis of the year in Educational Computing. The model was implemented at the Distance Education Division (DEAD) of IFCE and at the School of Public Management of the State of Ceará, as well as in a Virtual Learning Environment we called Help Class (built on Moodle) for use in Physics and Science classes.

Another contribution was the Quantum Duck (Sales *et al.*, 2008), a learning object (LO) focused on the photoelectric effect. I also developed the Interactive Seesaw (Oliveira *et al.*, 2006), a learning object covering static equilibrium concepts with interdisciplinary applications in logical-mathematical reasoning, and supervised other student works along the same lines, such as The Physics of the Ballerina. There are articles published covering each of these projects.

I was also involved in outreach projects such as CIARTEC (the Science, Art and Technology Workshops) a group dedicated to bringing science and mathematics to schools in an engaging and playful way. I should also mention the 5W2H in Teaching Planning and the 6Cs Didactic Sequence, the latter of which is currently being investigated and applied in greater depth by some of my doctoral students at RENOEN.

I: In your dissertation, you draw connections with Psychology. How did this influence your theoretical foundations and your practice in Science Teaching?

PS: That connection was almost inevitable for someone like me, who has been teaching for over three decades and has always sought to understand why some students learn and others don't, even when exposed to the same content. Over the course of my career, I came to realize that teaching Physics alone was not enough — it is essential to understand the learner as a person: their context, their background, and the mediations that surround them.

Vigotski came into my practice precisely for that reason. The concept of the Zone of Proximal Development resonated deeply with me,

because it captures something I had already been experiencing intuitively: the teacher's role as a mediator between what the students already know and what they are still capable of learning. In my Physics Teaching Methodology courses and in the development of Learning Objects and Digital Educational Resources, this perspective began to shape the way I designed learning activities.

Interaction and language play a central role in my classroom practices: in forums, wikis, and activities within the Help Class environment. The dialogue between learners, mediated by signs and tools, is precisely what we aim to foster when using technology in a pedagogically grounded way. That is, in fact, the very foundation of the Learning Vectors model!

I: How do you evaluate the contributions of Reuven Feuerstein's theory to classroom practices in Science Teaching?

PS: Feuerstein does have a place in my work. I have already mentioned him in a paper, though we have not explored his ideas as deeply as we have Vigotski's. I increasingly believe in the transformative potential of his theory for education in general, not just in Science Teaching, especially in contexts of educational vulnerability, which is a daily reality faced by Federal Institutes and Universities across the country. It was through reading his work that I came to see intelligence as plastic, as malleable, rather than something fixed and rigid. Like him, I believe every human being has the capacity to learn, to grow, and to overcome limitations — as long as the right mediation is in place. That is truly revolutionary in a country that still labels students as “good” or “bad” based on a written test.

I: Which academic or professional experience related to Science Teaching do you consider the most significant, and how did it shape your work in this area?

PS: That's a hard one... One that stands out is the defense of my doctoral dissertation and, above all, the award that came a year later. It made five attempts to get into the doctoral program: many rejections and a lot of persistence! When I finally defended in 2010, among the five finalists for the best thesis award was a student supervised by a committee member who had criticized me harshly during my defense, and not very constructively at that. Winning that award (best thesis of the year in Educational Computing, granted by the Brazilian Computer Society) was a victory with a very special taste.

Another experience that left a deep mark on me was the FEDERAL-VEST program in Juazeiro do Norte city, in the early 2000s. It was a university entrance preparatory course that I coordinated in partnership with the local government, serving an average of 300 students per night. Seeing young people from humble backgrounds, with no access to private prep courses, sitting in that auditorium, studying with determination to change their lives... my entire teaching philosophy is rooted in that experience: public education as an instrument of social transformation.

I: How do you assess Science Teaching in contemporary Basic and Higher Education in Brazil?

PS: Teaching continues to be treated as something to get through to pass the ENEM or university entrance exams, rather than as a means of understanding the world. Teacher training remains fragile

in many institutions, and the infrastructure of public schools is often precarious. But there are signs of change! The new generation of teachers enters their training with a different mindset: they want to know how to use technology, they want to apply active methodologies, they understand that the student is an active participant in the learning process, and they value inquiry as a teaching method....

What is missing, in my point of view, is for the research produced at universities and colleges to reach classrooms with greater impact. There is a significant gap between what is generated in graduate programs and what teachers experience in their daily lives. Bridging that divide is the great challenge. And that is precisely the role of public educational institutions: to connect teaching, research, and outreach in a way that allows the knowledge produced to resonate in the public schools where our students will eventually work.

I: What are your perspectives and expectations for the future of Science Education in Brazil, considering the challenges you currently identify in the area?

PS: I'd like to invite everyone to read a paper that came out of my postdoctoral research, developed collaboratively with other prominent researchers (Sales *et al.*, 2022). It discusses how I envision Education in 2050. Everything is very uncertain, with changes happening rapidly, but it is not a pessimistic vision, not at all! It is a vision of hope. Schools need to prepare students to deal with the unknown, to reinvent themselves multiple times throughout their lives. And technology will be our partner in that journey: we discuss this at length in the paper. What I dream of for 2050 are students who are true agents: builders, entrepreneurs, citizens who are aware

of their place in the world, and who know how to navigate this ocean of uncertainty without being swept away by it, all while taking care of their mental health. I also like to say that learning is something quantum: just like in the famous Schrödinger's Cat thought experiment, we never know whether a student has truly learned something until we somehow try to access what is inside them. And in the very act of trying to find out, we already changed the process. Every human being learns at their own pace, and I hope that assessment practices will evolve to take that into account.

I: Professor Gilvandenys, it has been a tremendous pleasure speaking with you. Thank you so much for your time and for sharing such rich and thoughtful reflections.

PS: The pleasure was entirely mine! You know, when we look back and see everything we have built over the course of a career, an overwhelming sense of gratitude takes hold. Every student, every classroom, every challenge... it was all worth it. Thank you for the opportunity.

4. FINAL CONSIDERATIONS AND FUTURE WORKS

This article presented, through a qualitative interview, the academic, professional, and scientific trajectory of Professor Dr. Gilvandenys Leite Sales, highlighting his contributions to Science Education, especially in the areas of formative assessment, educational technologies, active methodologies, and learning mediation. Throughout the text, experiences that articulate teaching, research, and outreach were emphasized, as well as the theoretical foundations that support his pedagogical practice, particularly the contributions of Vigotski and Feuerstein.

The reflections presented by the interviewee make it possible to understand that Science Teaching goes beyond the simple transmission of content, requiring contextualized, investigative, and student-centered pedagogical practices. Professor Sales' trajectory demonstrates that educational innovation emerges from the articulation between teaching experience, social commitment, and the continuous pursuit of professional development. In this sense, his contributions, such as the Learning Vectors model, learning objects, and methodological proposals focused on cognitive mediation, reveal concrete possibilities for transforming educational practice.

Furthermore, the interview highlighted the importance of understanding students in their entirety, considering their sociocultural contexts, potentialities, and different learning rhythms. The discussions on mediation, cognitive plasticity, and the pedagogical use of technologies reinforce the need for a more humanized, inclusive, and contemporary educational approach. The relevance of public educational institutions as spaces for scientific production, critical formation, and social transformation was also emphasized.

As a perspective for future research, it is recommended that a systematic review be conducted on the academic output of Professor Sales. This type of investigation could help map the main themes, theoretical frameworks, methodologies, and contributions the author has made to Science Teaching, while also identifying gaps and opportunities for further investigation.

ETHICAL ASPECTS

This study did not require submission to the Research Ethics Committee, in accordance with Art. 1, sole paragraph, of Resolution CNS No. 510/2016, specifically item III (research using information in the public domain such as Lattes Platform and Google Scholar), as it was based on an interview with a well-known academic and on already published and widely available scientific articles, with no collection of sensitive data or risk of improper identification of participants. Nevertheless, the study was conducted with the participant's prior authorization, ensuring that participation was entirely voluntary. The participant was informed about the objectives and nature of the study and was free to decline participation, refuse to answer any questions, or withdraw consent at any stage, without any prejudice or negative consequences.

REFERENCES

ARANTES, S. L. F. Vigotski e a educação em ciências: uma revisão integrativa da literatura. **Revista Pesquisa Qualitativa**, v. 11, n. 26, p. 127-146, 2023. ShortDOI: <https://doi.org/q56k>

BELÍSSIMO, J. R.; NARDI, R. A formação de professores de Física no século XXI: o que preconizam as teses brasileiras sobre a comunidade científica da área. **Revista de Enseñanza de la Física**, Córdoba, v. 38, n. 1, p. 29-35, 2026. ShortDOI: <https://doi.org/q5xq>

FEUERSTEIN, R.; FEUERSTEIN, R. S.; FALIK, L. H.; RAND, Y. **Além da inteligência**: aprendizagem mediada e a capacidade de mudança do cérebro. Petrópolis: Vozes, 2023.

FREIRE, P. **Pedagogia da autonomia**: saberes necessários à prática educativa. 2 ed. Rio de Janeiro: Paz & Terra, 2025.

GIL, A. C. **Métodos e técnicas de pesquisa social**. 8. ed. São Paulo: Atlas, 2026.

IMBERNÓN, F. **Formação docente e profissional: formar-se para a mudança e a incerteza**. São Paulo: Cortez, 2022.

LEVINSON, R.; JANNING, D. P.; CARVALHO, F. A.; CAURIO, M. S.; CASSIANI, S. Diálogos sul e norte global e possibilidades democráticas nas educações em ciências: entrevista com o Prof. Dr. Ralph Levinson. **Vitruvian Cogitationes**, v. 5, n. 2, e024016, 2024. DOI: <https://doi.org/10.4025/rvc.e024016>

OLIVEIRA, E.; SALES, G.; FILHO, J.; MACÊDO, L.; FREIRE, R. Gangorra interativa: um objeto de aprendizagem para os conceitos de grandezas inversamente proporcionais. *In*: WORKSHOP DE INFORMÁTICA NA ESCOLA, 1., 2006. **Anais [...]**. [S. l.]: CBIE, 2006.

PAIXÃO, J. L. Distanciamento historicamente construído entre a produção científica universitária e a prática cotidiana das salas de aula da Educação Básica. **Tópicos**, v. 4, n. 29, p. 1-20, 2026. ShortDOI: <https://doi.org/q5xr>

SANTOS, L. S. dos. Formação continuada dos professores e os impactos no processo de ensino e aprendizagem. **Tópicos**, v. 3, n. 28, p. 1-20, 2025.

SALES, G. L.; VASCONCELOS, F. H. L.; FILHO, J. A. C.; PEQUENO, M. C. Atividades de modelagem exploratória aplicada ao ensino de física moderna com a utilização do objeto de aprendizagem pato quântico. **Revista Brasileira de Ensino de Física**, v. 30, n. 3, 2008.

SALES, G. L. **Learning Vectors (LV):** um modelo de avaliação da aprendizagem em EaD online aplicando métricas não-lineares. 2010. 238 f. Tese (Doutorado em Engenharia de Teleinformática) - Centro de Tecnologia, Universidade Federal do Ceará, Fortaleza, 2010.

SALES, G. L.; TAVARES, A. M. B. N.; SILVA, B. D.; SILVA, E. J. C. S. Educação 2050: pensar o futuro em tempos de mudanças aceleradas. **Holos**, v. 4, e13962, 2022.

SILVA, L. N.; ALMEIDA, C. P. M.; VELOSO, M. S. S. O. Plataforma Moodle no ensino: uma proposta de aprendizagem na formação de conceitos de Ciências. **Revista Valore**, v. 6, ed. especial, p. 1185-1199, 2021.

SILVA, A. R. S.; SALES, G. L.; SOARES, J. M. **Reuven Feuerstein: A Systematic Review And Bibliometrics.** Owl Journal, v.4, n. 5, 2026.

TAHERDOOST, H. **Navigating Qualitative Research:** a comprehensive guide to methods and practices. London and New York: Routledge, 2026.

TORLIG, E. G. S.; RESENDE JUNIOR, P. C.; FUJIHARA, R. K.; MONTEZANO, L.; DEMO, G. Proposta de Validação para Instrumentos de Pesquisa Qualitativa (Vali-Quali). **Administração: Ensino e Pesquisa**, v. 23, n. 1, p. 5-31, 2022. ShortDOI: 10.13058/raep.2022.v23n1.2022.

VIGOTSKI, L. S. **A formação social da mente:** o desenvolvimento dos processos psicológicos superiores. 7. ed. São Paulo: Martins Fontes, 2007.

¹ Doctoral Student in Science Teaching, Northeast Teaching Network, Federal Institute of Education, Science and Technology of Ceará, Fortaleza, Ceará, Brazil. E-mail: [acesse o artigo original para visualizar o e-mail](#). Orcid: <https://orcid.org/0000-0002-2799-5795>

² Doctor in Teleinformatics Engineering, Federal University of Ceará, Fortaleza, Ceará, Brazil. E-mail: [acesse o artigo original para visualizar o e-mail](#). Orcid: <https://orcid.org/0000-0002-6060-2535>

³ Doctor in Réseaux, Connaissances et Organisations pelo Institut National de Télécommunications, France. E-mail: [acesse o artigo original para visualizar o e-mail](#). Orcid: <https://orcid.org/0000-0002-5111-5794>