IJSRIS journal

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH AND INNOVATIVE STUDIES

ISSN: 2820-7157

www.ijsrisjournal.com

April 2026 Volume 5 Number 2 616-625

Received Date: 22 February 2026 Accepted Date: 14 March 2026 Published Date: 2 April 2026

Computational Physics as an Inclusive Didactic Framework for Autistic Students in Higher Science, Technology, Engineering, and Mathematics Education

Jihane MELLOUI [1], Zakaria MIGHOUAR [1], Moulay El Houssine ECH-CHHIBAT [1], Laidi ZAHIRI [1]

1. M2S2I Laboratory, ENSET Mohammedia, Hassan II University of Casablanca, Casablanca, Morocco

Abstract

Students on the autism spectrum frequently demonstrate remarkable intellectual strengths in science, technology, engineering, and mathematics, particularly in disciplines requiring advanced pattern recognition, logical reasoning, and systematic problem solving. Despite these cognitive advantages, autistic students experience disproportionately high dropout rates in university physics programs. This paradox arises less from the intrinsic complexity of physics than from the pedagogical barriers embedded in traditional instruction, including sensory-overloading laboratory environments, linguistically ambiguous problem statements, and the social demands of collaborative learning.

This conceptual study investigates how computational physics can be redesigned as an inclusive pedagogical framework that capitalizes on the cognitive strengths of autistic students while minimizing environmental, linguistic, and social barriers to learning.

Grounded in Simon Baron-Cohen's Empathizing–Systemizing theory, the proposed framework replaces conventional laboratory activities with highly structured computational learning environments based on Python programming and physics simulations designed according to user interface and user experience principles. The framework incorporates explicit algorithmic instruction, sensory-conscious digital environments, deterministic learning activities, and transparent assessment strategies tailored to the cognitive characteristics of autistic learners.

The proposed approach is expected to improve student retention, conceptual engagement, learning autonomy, and psychological well-being by creating predictable and cognitively accessible learning environments. The article introduces comparative pedagogical models, conceptual frameworks, and instructional workflows illustrating how computational physics can reduce sensory and cognitive barriers while promoting deeper conceptual understanding.

Computational physics offers a natural alignment with the cognitive profile frequently associated with autism by emphasizing logical structure, predictability, and systematic reasoning. Designing physics instruction according to principles of neurodiversity and inclusive pedagogy has the potential to transform barriers into opportunities, enabling higher education institutions to better support autistic students while fostering scientific excellence through cognitive diversity.

Keywords: Neurodiversity; Autism Spectrum; Computational Physics; Physics Education; Inclusive Education; Science, Technology, Engineering, and Mathematics Education; Universal Design for Learning; Empathizing–Systemizing Theory; Higher Education.

Introduction

- **The Paradox of Autism in Science, Technology, Engineering, and Mathematics Education**

The relationship between autism and education in science, technology, engineering, and mathematics is characterized by a striking paradox. A growing body of research indicates that individuals on the autism spectrum are disproportionately represented in scientific and technical disciplines compared with the general population (Wei et al., 2013; Chen et al., 2015). Their cognitive profile, often characterized by sustained attention, exceptional attention to detail, strong analytical reasoning, and a preference for structured, rule-based systems, aligns closely with the epistemological foundations of physics (Frith, 2003; Baron-Cohen et al., 2007).

Despite these cognitive strengths, autistic students remain underrepresented among graduates in physics and other scientific disciplines and experience disproportionately high attrition rates throughout higher education (MacLeod & Green, 2009; Gobbo & Shmulsky, 2014). This apparent contradiction suggests that academic difficulties frequently arise not from the conceptual demands of physics itself, but from the pedagogical environments in which physics is traditionally taught. Conventional instructional approaches often rely on sensory-intensive laboratory activities, implicit communication, ambiguous problem statements, and highly social collaborative learning, all of which may create significant barriers for autistic learners.

Although previous studies have extensively investigated autism in higher education and have separately examined innovations in computational physics education, little attention has been devoted to understanding how computational physics can serve as an inclusive pedagogical framework specifically designed to accommodate the cognitive characteristics of autistic students. Addressing this gap constitutes the central motivation of the present study.

- **Didactic Barriers for Neurodivergent Students**

Traditional university physics instruction has historically been developed according to pedagogical assumptions that primarily reflect the learning characteristics of the majority of students. While these approaches are effective for many learners, they may unintentionally create barriers for autistic students whose cognitive and sensory processing differs from conventional educational expectations.

One important challenge concerns the physical learning environment. University physics laboratories are frequently characterized by high levels of sensory stimulation, including bright lighting, background noise, crowded workspaces, and simultaneous experimental activities. Such environments may contribute to sensory overload and reduce students' capacity to concentrate on conceptual learning (Bogdashina, 2016).

A second challenge relates to the social organization of learning. Contemporary physics education increasingly promotes active learning strategies that involve collaborative problem solving and group-based laboratory activities (Mazur, 1997). Although these approaches have demonstrated educational benefits for many students, they may represent an additional source of cognitive and emotional demand for autistic learners who often prefer structured, predictable, and clearly defined forms of interaction.

Finally, the linguistic characteristics of physics instruction may constitute another significant barrier. Physics problems are commonly expressed through natural language that contains implicit assumptions, contextual information, figurative expressions, or ambiguities requiring pragmatic interpretation. Because many autistic students tend to process language in a more literal and explicit manner, these implicit elements may increase cognitive load independently of the underlying physical concepts being assessed.

Together, these environmental, social, and linguistic factors suggest that difficulties experienced by autistic students may arise not only from the intrinsic complexity of physics but also from the design of the instructional environment. Recognizing these barriers provides the foundation for developing more inclusive pedagogical approaches based on computational physics.

- **Research Objective: Computational Physics as an Inclusive Didactic Framework**

The present study investigates the potential of computational physics to serve as an inclusive pedagogical framework for autistic students in higher education. Rather than considering computational physics solely as a scientific or numerical discipline, this article examines its educational value as a structured learning environment capable of reducing several barriers associated with traditional physics instruction.

Computational physics translates physical phenomena into explicit computational models through programming and interactive digital simulations. This transformation replaces many implicit linguistic and procedural elements with transparent algorithmic representations, allowing physical concepts to be explored through deterministic and reproducible computational processes. Such characteristics closely align with cognitive preferences frequently reported among autistic learners, including a preference for logical organization, predictability, systematic reasoning, and explicit instructions.

Building upon this perspective, the article proposes a conceptual didactic framework that integrates computational modeling, structured instructional design, sensory-conscious digital environments, and transparent assessment strategies. The objective is not to replace traditional laboratory instruction, but to complement existing pedagogical practices with learning environments that are more accessible, predictable, and inclusive for autistic students while preserving the conceptual rigor of university physics education.

1. Theoretical Framework

1.1. The Empathizing–Systemizing Theory

The conceptual framework proposed in this study is grounded in Simon Baron-Cohen's Empathizing–Systemizing theory (Baron-Cohen, 2009). This theoretical perspective suggests that autistic individuals often exhibit a cognitive profile characterized by comparatively lower empathizing, defined as the capacity to identify and respond to the mental states of others, together with average or enhanced systemizing, which refers to the drive to analyze, understand, predict, and construct rule-governed systems.

Among scientific disciplines, physics represents one of the most structured examples of a rule-based system. Physical phenomena are described through mathematical laws, logical relationships, and deterministic models that enable the prediction of natural processes under clearly defined conditions. Consequently, the analytical and systematic reasoning frequently associated with autism may represent a valuable cognitive asset for understanding many concepts in physics, particularly those requiring pattern recognition, logical inference, and model construction (Baron-Cohen et al., 2007).

This theoretical perspective provides the educational rationale for the present work. If computational physics translates physical phenomena into explicit algorithms, numerical models, and reproducible simulations, then its pedagogical characteristics become closely aligned with the cognitive preferences described by the Empathizing–Systemizing theory. Rather than relying on implicit communication or socially mediated learning, computational approaches emphasize logical organization, explicit procedures, predictability, and systematic reasoning. These characteristics constitute the theoretical foundation of the inclusive didactic framework proposed in this article.

1.2. The Importance of Predictability in Computational Physics Learning

A frequently reported characteristic of the autistic cognitive profile is a preference for predictability, routine, and clearly structured environments (Grandin, 2006). In educational settings, predictable learning experiences can reduce uncertainty and allow students to devote greater cognitive resources to understanding disciplinary concepts rather than adapting to constantly changing contextual conditions.

Traditional university physics laboratories often involve multiple sources of variability. Experimental equipment may behave differently across sessions, measurements may be affected by experimental uncertainty, and laboratory activities frequently require continuous social interaction and adaptation to dynamic situations. Although these characteristics reflect authentic scientific practice, they may also increase the cognitive demands placed on autistic students independently of the physics concepts being studied.

Computational physics provides a complementary learning environment characterized by explicit procedures, reproducible computational models, and well-defined algorithmic workflows. Given identical initial conditions and parameters, a computational model—such as a Python simulation of pendulum motion—generally produces consistent and reproducible outputs. This level of predictability allows students to concentrate on the underlying physical principles without simultaneously managing unnecessary environmental or procedural variability.

From the perspective of cognitive load theory (Sweller, 1988), reducing avoidable sources of uncertainty may decrease extraneous cognitive load, thereby enabling learners to allocate greater working-memory resources to conceptual reasoning, mathematical modeling, and scientific problem solving. Consequently, predictability represents not merely a technical characteristic of computational physics but a pedagogically significant feature that may contribute to more accessible and inclusive physics education for autistic students.

The relationship between the cognitive characteristics frequently associated with autism and the two instructional environments is summarized in **Figure 1**. Traditional physics instruction may generate a mismatch through sensory stimulation, implicit communication, unpredictable laboratory conditions, and unstructured social interaction. In contrast, computational physics can provide a more compatible learning environment based on explicit algorithms, reproducible procedures, controllable sensory conditions, and structured forms of participation.

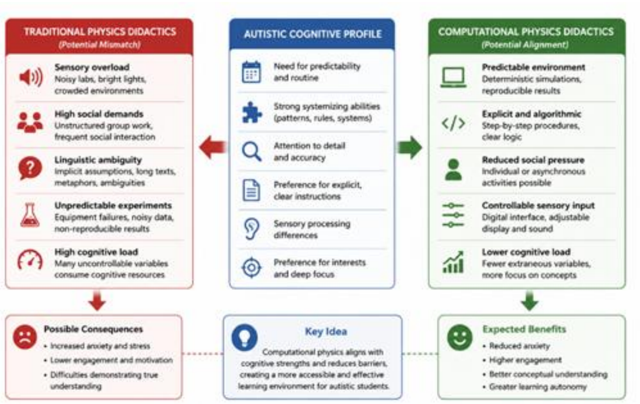

Figure 1. Conceptual mapping of the alignment between cognitive characteristics frequently associated with autism and traditional or computational physics learning environments.

1.3. Information Processing and Sensory Gating

Autistic individuals may experience differences in sensory gating, defined as the neurological process through which the brain filters, prioritizes, and suppresses sensory information that is not immediately relevant to the task being performed (Pellicano & Burr, 2012). These differences can influence how multiple auditory, visual, and tactile stimuli are processed simultaneously within complex educational environments.

A traditional physics laboratory frequently contains competing sources of sensory information, including equipment noise, ventilation systems, conversations, alarms, bright lighting, and moving objects. While some students may be able to filter out these background stimuli and focus primarily on the instructor's explanations, autistic students with heightened sensory sensitivity may experience greater difficulty distinguishing relevant information from surrounding sensory input. For example, the continuous hum of an oscilloscope or ventilation system may remain highly salient and compete with the teacher's voice for attentional resources.

This increased competition between sensory inputs may contribute to sensory fatigue, reduced concentration, and higher extraneous cognitive load. As a result, a portion of the learner's working-memory capacity may be directed toward managing the surrounding environment rather than interpreting experimental observations or understanding the physical principles being studied.

Computational learning environments may help reduce these demands by allowing students to control screen brightness, sound levels, interface complexity, and the pace of interaction. However, the use of digital tools should not be considered inherently accessible. Their educational value depends on the deliberate design of sensory-conscious interfaces that minimize unnecessary stimulation while preserving the information required for conceptual learning.

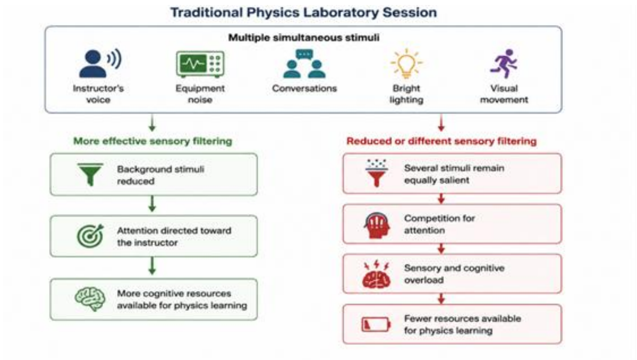

Figure 2. Conceptual model of sensory filtering and information processing in a traditional physics laboratory.

The conceptual relationship between sensory information processing and learning in traditional physics laboratories is illustrated in **Figure 2**. The figure highlights how the same learning environment may be experienced differently depending on the learner's ability to filter competing sensory stimuli. Rather than representing a deficit, these differences in sensory processing may influence the allocation of cognitive resources during laboratory activities and, consequently, the capacity to focus on conceptual physics learning.

2. Didactic Barriers in Traditional Physics Education

The successful implementation of inclusive computational physics requires a clear understanding of the pedagogical challenges associated with conventional physics instruction. While traditional laboratory-based teaching remains fundamental for developing experimental competencies, several characteristics of these learning environments may unintentionally create additional cognitive and sensory demands for autistic students. Identifying these challenges provides the basis for designing instructional adaptations that preserve the scientific objectives of physics education while improving accessibility and inclusiveness.

2.1. Sensory Load Analysis

The physical characteristics of university laboratories expose students to multiple simultaneous sensory stimuli, including background noise, bright lighting, crowded workspaces, and continuous physical interactions with laboratory equipment. Although these conditions are generally considered part of authentic experimental practice, they may increase sensory and cognitive demands for autistic learners. In contrast, computational learning environments offer greater opportunities to regulate sensory stimulation and personalize the learning experience.

Table 1 summarizes the principal differences between traditional laboratory environments and computational physics learning environments from the perspective of sensory accessibility.

Table 1. Comparison of sensory characteristics between traditional and computational physics learning environments

Sensory Dimension	**Traditional Physics Laboratory**	**Computational Physics Learning Environment**
Auditory	Background conversations, equipment noise, ventilation systems.	Adjustable sound levels and the possibility of a quiet individual workspace.
Visual	Bright laboratory lighting, multiple visual stimuli, crowded workspaces.	Adjustable screen brightness, minimalist interfaces, dark mode when appropriate.
Tactile	Shared laboratory equipment with varying physical characteristics.	Familiar and consistent interaction through personal computer peripherals (keyboard and mouse).

The differences between traditional laboratory instruction and computational physics learning environments extend beyond instructional methods to include the sensory characteristics of the learning context. From an inclusive education perspective, these environmental features may influence students' cognitive engagement and their ability to concentrate on conceptual reasoning. **Table 1** provides a comparative overview of the principal sensory characteristics of both learning environments, highlighting how computational physics can offer greater opportunities for sensory regulation and individualized learning.

2.2. Linguistic Ambiguity in Physics Problem Statements

The interpretation of physics problems depends not only on conceptual understanding but also on the ability to infer implicit information embedded within natural language. Many traditional physics exercises assume that students can recognize unstated conditions, interpret qualitative expressions, and identify contextual information that is not explicitly provided. While these conventions are generally well understood within physics education, they may represent an additional cognitive demand for autistic students who often prefer precise, explicit, and unambiguous communication.

For example, a conventional problem statement such as *"A block slides down a rough incline. Determine its final speed."* implicitly requires students to infer the existence of kinetic friction, assume appropriate initial conditions, and identify the physical parameters necessary to solve the problem. These implicit assumptions may increase cognitive load independently of the underlying physics concepts.

Computational physics offers an alternative instructional representation in which every physical quantity, parameter, and boundary condition must be explicitly defined before numerical computation can begin. This explicit algorithmic formulation reduces linguistic ambiguity and enables students to focus more directly on physical modeling and scientific reasoning.

The contrast between these two instructional approaches is illustrated in **Table 2**.

Table 2. Comparison between traditional physics problem statements and explicit computational representations.

Traditional Physics Problem Statement	**Computational Physics Representation**
A block slides down a rough incline.	def simulate_slide (mass_kg, mu_k, angle_rad, initial_velocity=0.0):
Assume air resistance is negligible.	air_density = 0.0 (Explicit boundary condition)
Determine the instant when the block reaches the ground.	while altitude > 0.0: update_kinematics()

3. Inclusive Didactic Adaptations through Computational Physics

Building upon the theoretical framework presented in the previous sections, this study proposes a set of didactic adaptations based on computational physics to improve the accessibility of university physics education for autistic students. Rather than replacing traditional laboratory instruction, these adaptations are intended to complement existing teaching practices by reducing unnecessary sensory, linguistic, and social barriers while preserving the conceptual and experimental objectives of physics education.

The proposed framework emphasizes explicit instructional design, structured computational modeling, predictable learning environments, and flexible forms of interaction. These characteristics are consistent with the cognitive preferences described by the Empathizing–Systemizing theory and the principles of inclusive education.

Table 3 summarizes the proposed pedagogical adaptations by comparing selected characteristics of traditional physics instruction with computational alternatives and their expected educational contributions.

Table 3. Proposed didactic adaptations for inclusive computational physics education

Traditional Instructional Practice	Potential Challenge for Autistic Students	Computational Physics Adaptation	Expected Educational Contribution
Physical laboratory activities	Multiple sensory stimuli and variable experimental conditions	Digital physics simulations	Greater environmental control and reproducible learning experiences
Natural language problem statements	Implicit assumptions and linguistic ambiguity	Algorithmic and code-based problem formulation	Explicit representation of variables, parameters, and procedures
Face-to-face collaborative laboratory work	High social interaction demands and unpredictable communication	Structured asynchronous code review and collaborative programming	More predictable communication and flexible participation

3.1. User Interface and User Experience Design for Physics Simulations

The effectiveness of computational physics as an inclusive learning environment depends not only on the scientific accuracy of the simulations but also on the design of the digital interface through which students interact with physical concepts. User interface and user experience design should therefore aim to minimize unnecessary sensory stimulation while promoting clarity, predictability, and ease of interaction.

Several design principles can contribute to a more accessible computational learning environment:

- **Visual simplicity**: Digital interfaces should minimize unnecessary graphical elements, decorative animations, and visual distractions so that students can focus their attention on the physical concepts being explored.

- **Adjustable visual presentation**: Simulations should allow users to personalize screen brightness, contrast, color themes, and font size according to their individual sensory preferences. Dark display modes may be beneficial for some learners by reducing visual discomfort, although interface customization should remain user-controlled.

- **Explicit and precise interaction**: Numerical parameters should be entered through precise input fields in addition to graphical controls such as sliders. Allowing direct numerical input improves accuracy, reproducibility, and predictability during computational experiments.

- **Consistent interface organization**: Menus, icons, navigation pathways, and visualization layouts should remain stable throughout the learning activity in order to reduce unnecessary cognitive demands associated with interface exploration.

- **Immediate and transparent feedback**: Each modification of a simulation parameter should generate clear and understandable feedback, enabling students to establish explicit relationships between computational inputs and physical outcomes.

Collectively, these design principles contribute to learning environments that are more predictable, accessible, and cognitively supportive while preserving the scientific objectives of computational physics education.

3.2. Computational Programming as an Explicit Instructional Language

Computational programming provides an instructional representation in which physical concepts, mathematical relationships, and boundary conditions must be explicitly specified before numerical computation can be performed. Unlike traditional assessment tasks that may require students to infer implicit assumptions from natural language, computational modeling requires every variable, parameter, and initial condition to be clearly defined.

From an educational perspective, this explicit representation reduces linguistic ambiguity and encourages students to focus on the underlying physical principles rather than on interpreting the wording of a problem statement. Programming therefore becomes not only a computational tool but also an instructional language through which scientific reasoning is organized, communicated, and evaluated.

Within this framework, assessment shifts from producing written explanations alone to constructing computational models that demonstrate conceptual understanding through reproducible scientific reasoning. Rather than replacing conventional assessment methods, computational programming offers an additional means of evaluating students' ability to translate physical laws into structured algorithmic representations.

An example of such an explicit computational prompt is presented below.

```python
# Computational Physics Task
# Objective: Compute the final velocity of a block sliding on an inclined plane.

def calculate_velocity(
    mass_kg: float,
    incline_angle_rad: float,
    friction_coefficient: float,
    initial_velocity_m_s: float = 0.0
) -> float:
    """
    Parameters
    ----------
    mass_kg : float
        Mass of the block (kg)
    incline_angle_rad : float
        Incline angle (radians)
    friction_coefficient : float
        Coefficient of kinetic friction
    initial_velocity_m_s : float
        Initial velocity (m/s)

    Task
    ----
    Implement Newton's Second Law to compute the final velocity.
    """

    # Student implementation

    pass
```

Figure 3. Example of an explicit computational physics programming task for modeling an inclined-plane motion.

The computational prompt illustrates how programming transforms an implicitly formulated physics exercise into an explicit sequence of scientifically defined variables and operations. Every physical parameter, boundary condition, and computational step is clearly identified, thereby reducing unnecessary linguistic interpretation and allowing students to concentrate on conceptual reasoning, mathematical modeling, and scientific problem solving. This explicit instructional structure is consistent with the inclusive pedagogical framework proposed throughout this study.

4. Evaluation and Expected Educational Outcomes

4.1. Towards More Inclusive Assessment Practices

Assessment constitutes an essential component of physics education because it determines not only students' academic performance but also the learning strategies they adopt throughout the course. Traditional assessment in university physics frequently relies on time-constrained, high-stakes written examinations conducted in large examination halls. Although these assessment methods provide standardized evaluation procedures, they may introduce additional sensory, emotional, and organizational demands that are unrelated to students' conceptual understanding of physics.

Computational physics enables the implementation of complementary assessment strategies based on continuous learning activities and computational artifacts. Programming assignments, numerical simulations, iterative model development, and structured code reviews provide opportunities to evaluate students' conceptual reasoning throughout the learning process rather than exclusively through a single summative examination.

Furthermore, computational assessment facilitates immediate automated feedback, progressive refinement of scientific models, and reproducible evaluation criteria. Such approaches may reduce unnecessary sources of stress while allowing students to demonstrate their understanding through explicit computational reasoning and problem-solving processes.

Figure 4 illustrates the conceptual transition from a predominantly summative assessment model toward a continuous computational assessment framework that emphasizes progressive learning, structured feedback, and reproducible scientific practice.

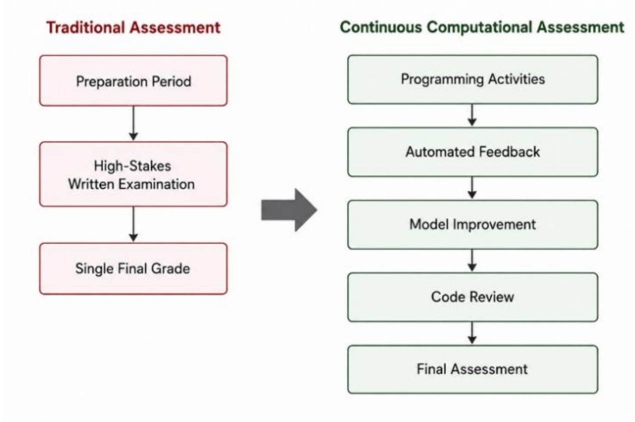

Figure 4. Conceptual comparison between traditional summative assessment and continuous computational assessment in university physics

4.2. Cognitive Load Reallocation

According to Cognitive Load Theory (Sweller, 1988), learning effectiveness depends on how learners allocate their limited working-memory resources among intrinsic, extraneous, and germane cognitive load. In traditional physics laboratories, sensory distractions, ambiguous instructions, and unpredictable learning conditions may increase extraneous cognitive load, leaving fewer cognitive resources available for conceptual reasoning and scientific problem solving.

The inclusive computational framework proposed in this study seeks to reduce these avoidable sources of cognitive demand through explicit algorithmic instruction, structured computational activities, and customizable digital learning environments. By minimizing unnecessary sensory and linguistic processing, a greater proportion of working-memory resources may be devoted to understanding physical concepts, constructing computational models, and developing scientific reasoning.

It is important to emphasize that the intrinsic complexity of physics remains unchanged. Rather than simplifying the scientific content, computational physics aims to reduce avoidable cognitive demands that are unrelated to conceptual learning. Consequently, the proposed framework supports a reallocation of cognitive resources from environmental and procedural processing toward meaningful engagement with physics concepts.

Figure 5 and **Figure 6** present a conceptual illustration of this redistribution of cognitive load between traditional laboratory instruction and computational physics learning environments. The diagrams are intended to illustrate the theoretical principles of Cognitive Load Theory and should not be interpreted as quantitative measurements.

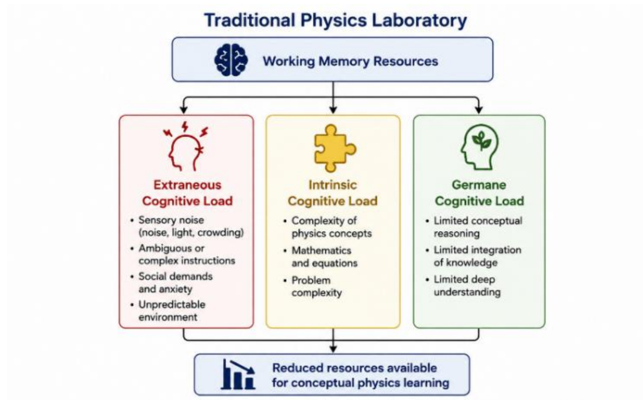

Figure 5. Conceptual allocation of working-memory resources during traditional physics laboratory instruction.

Figure 5 illustrates the conceptual allocation of working-memory resources during traditional laboratory-based physics instruction. In this learning environment, a substantial proportion of cognitive resources may be devoted to managing sensory stimulation, interpreting implicit instructions, and adapting to dynamic laboratory conditions. These additional demands increase extraneous cognitive load without directly contributing to conceptual understanding of physics.

By contrast, the computational learning environment proposed in this study aims to reduce avoidable sources of cognitive demand while preserving the intrinsic complexity of physics. As illustrated in **Figure 6**, explicit computational instructions, predictable learning activities, and sensory-conscious digital environments may enable learners to allocate a greater proportion of their working-memory resources to conceptual reasoning, computational modeling, and meaningful scientific learning.

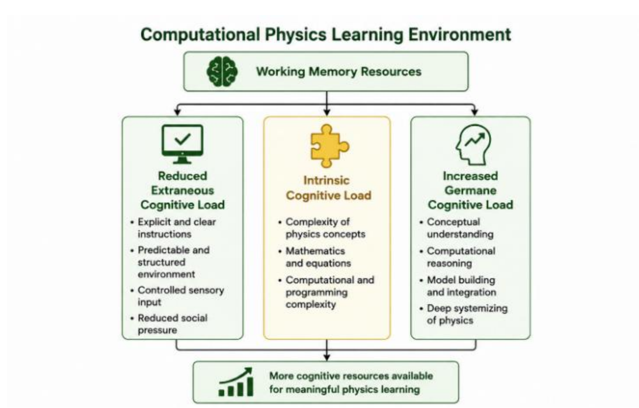

Figure 6. Conceptual allocation of working-memory resources in computational physics learning environments.

5. Discussion

The conceptual framework proposed in this study suggests that computational physics can contribute to more inclusive physics education by reducing environmental, linguistic, and procedural barriers that may interfere with conceptual learning. Rather than modifying the scientific content of physics, the proposed approach focuses on redesigning the learning environment so that students can devote a greater proportion of their cognitive resources to understanding physical principles and developing computational reasoning. This perspective is consistent with Cognitive Load Theory (Sweller, 1988), which emphasizes the importance of minimizing unnecessary cognitive demands that do not directly support learning.

The proposed framework also aligns closely with the principles of Universal Design for Learning (Rose & Meyer, 2002). Although the didactic adaptations presented in this study are motivated by the learning characteristics frequently associated with autism, they have the potential to benefit a much broader student population. Explicit instructional design, predictable learning activities, flexible digital interfaces, and transparent assessment strategies may improve accessibility not only for autistic learners but also for students experiencing language barriers, cognitive overload, attention difficulties, or limited prior programming experience. Consequently, computational physics should not be viewed as a specialized accommodation but rather as an inclusive pedagogical approach capable of supporting learner diversity within higher education.

Beyond instructional design, successful implementation depends on institutional commitment. Many university instructors receive extensive scientific training but comparatively little preparation in inclusive pedagogy or neurodiversity. Professional development initiatives focusing on neurodiverse learning profiles, accessible assessment practices, and inclusive computational teaching strategies would therefore represent an important step toward wider adoption of the proposed framework. Such initiatives could help instructors distinguish between learning barriers created by the educational environment and the actual scientific abilities of their students.

Several limitations should also be acknowledged. First, this study presents a conceptual framework rather than an empirically validated instructional model. The educational benefits discussed throughout the article should therefore be interpreted as theoretically grounded hypotheses requiring experimental validation. Second, autism is characterized by substantial heterogeneity, and no single pedagogical approach can be expected to address the needs of every autistic learner. Consequently, the proposed framework should be considered as one possible pathway toward more inclusive physics education rather than a universal solution.

Future research should investigate the effectiveness of the proposed framework through classroom implementation, comparative experimental studies, and longitudinal evaluations involving both autistic and non-autistic students. In particular, future work could examine the impact of computational physics on conceptual understanding, cognitive load, learner engagement, academic achievement, and psychological well-being. The integration of learning analytics and artificial intelligence may further support adaptive computational learning environments capable of providing personalized feedback while preserving the transparency and predictability that constitute the foundation of the present framework.

Conclusion

This study has proposed a conceptual framework that positions computational physics as an inclusive pedagogical approach capable of supporting autistic students in higher physics education. Building upon the Empathizing–Systemizing theory, Cognitive Load Theory, and the principles of Universal Design for Learning, the framework demonstrates how explicit computational modeling, predictable learning environments, and structured instructional design may reduce unnecessary sensory, linguistic, and procedural barriers while preserving the conceptual rigor of university physics.

Rather than simplifying physics content, the proposed approach seeks to optimize the learning environment so that students can devote a greater proportion of their cognitive resources to conceptual reasoning, computational modeling, and scientific problem solving. Although the framework was developed primarily in response to the learning characteristics frequently associated with autism, many of the proposed pedagogical adaptations are consistent with inclusive teaching practices that may benefit a broader and more diverse student population.

The present work is conceptual in nature and therefore requires empirical validation through classroom implementation and experimental research. Future studies should evaluate the effectiveness of the proposed framework using quantitative and qualitative measures of conceptual understanding, cognitive load, learner engagement, academic achievement, and psychological well-being. Furthermore, the integration of learning analytics and artificial intelligence may provide additional opportunities to develop adaptive computational learning environments capable of delivering personalized feedback while maintaining transparency, predictability, and accessibility.

Ultimately, computational physics should be viewed not only as a scientific discipline but also as a promising educational framework for promoting more inclusive, evidence-based, and learner-centered physics education. By aligning instructional design with the diversity of learners' cognitive profiles, higher education institutions may create learning environments that support both scientific excellence and educational equity.

References

- Asperger, H. (1944). Die „Autistischen Psychopathen“ im Kindesalter. Archiv für Psychiatrie und Nervenkrankheiten, 117(1), 76-136.

- Baron-Cohen, S. (2009). Autism: The empathizing–systemizing (E-S) theory. Annals of the New York Academy of Sciences, 1156(1), 68-80.

- Baron-Cohen, S., Wheelwright, S., Burtenshaw, A., & Hobson, E. (2007). Mathematical talent is linked to autism. Human Nature, 18(2), 125-131.

- Blikstein, P. (2013). Digital fabrication and 'making' in education. FabLabs, 203-222.

- Bogdashina, O. (2016). Sensory perceptual issues in autism and Asperger syndrome: Different sensory experiences-different perceptual worlds. Jessica Kingsley Publishers.

- Chabay, R., & Sherwood, B. (2008). Computational physics in the introductory calculus-based course. American Journal of Physics, 76(4), 307-313.

- Chen, J. L., Leader, G., Sung, C., & Leahy, M. (2015). Trends in employment for individuals with autism spectrum disorder: a review of the research literature. Review Journal of Autism and Developmental Disorders, 2(2), 115-127.

- Frith, U. (2003). Autism: Explaining the enigma. Blackwell Publishing.

- Gobbo, K., & Shmulsky, S. (2014). Faculty experience with college students with autism spectrum disorders: A qualitative study of challenges and solutions. Focus on Autism and Other Developmental Disabilities, 29(1), 13-22.

- Grandin, T. (2006). Thinking in pictures: And other reports from my life with autism. Vintage.

- Halverson, E. R., & Sheridan, K. (2022). The maker movement in education. Harvard Educational Review, 84(4), 495-504.

- Happe, F., & Frith, U. (2006). The weak coherence account: detail-focused cognitive style in autism spectrum disorders. Journal of autism and developmental disorders, 36(1), 5-25.

- MacLeod, A., & Green, S. (2009). Beyond the books: Case study of a collaborative and holistic support model for university students with Asperger syndrome. Studies in Higher Education, 34(6), 631-646.

- Mazur, E. (1997). Peer instruction: A user's manual. Prentice Hall.

- Pellicano, E., & Burr, D. (2012). When the world becomes 'too real': a Bayesian explanation of autistic perception. Trends in cognitive sciences, 16(10), 504-510.

- Redish, E. F. (2003). Teaching physics with the physics suite. John Wiley & Sons.

- Rose, D. H., & Meyer, A. (2002). Teaching every student in the digital age: Universal design for learning. Association for Supervision and Curriculum Development.

- Sweller, J. (1988). Cognitive load during problem solving. Cognitive science, 12(2), 257-285.

- Viennot, L. (1996). Raisonner en physique. De Boeck Supérieur.

- Wei, X., Yu, J. W., Shattuck, P., McCracken, M., & Blackorby, J. (2013). Science, technology, engineering, and mathematics (STEM) participation among college students with an autism spectrum disorder. Journal of Autism and Developmental Disorders, 43(7), 1539-1546.

- Wing, L. (1981). Asperger's syndrome: a clinical account. Psychological medicine, 11(1), 115-129.