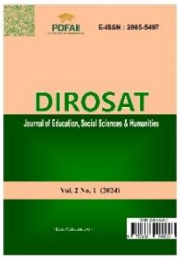

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Research Article

Integration of AI Applications in High School Physics, Kolb's Convergent Style

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Abstract. This study explores the integration of artificial intelligence (AI) applications in physics teaching at the secondary level. An interactive approach based on Kolb's learning model; The authors evaluated the convergent style of the kolb cycle with the use of simulations and AI-based data analysis systems to improve students' understanding of abstract physics concepts. The results show that these AI tools allow a more intuitive visualization of phenomena and facilitate the interpretation of experimental data. Students who used these resources demonstrated better performance and greater engagement with the subject. This research highlights the potential of AI to enrich physics learning in high school and opens the way to new innovative educational approaches.

Keywords: AI, Kolb Model, Abstract Concepts, High School Physics.

INTRODUCTION

Teaching physics represents a real challenge at the secondary level. Many students find it difficult to represent complex physical phenomena or interpret experimental data (Roger Freedman et al., 2015). These difficulties can have a negative impact on their motivation and performance in the subject. Faced with this observation, recent advances in artificial intelligence offer new perspectives for enriching the learning of physics. David Kolb (1984) developed an experiential learning model based on four learning styles: accommodating, assimilative, convergent and divergent. The tool used to help students identify how they learn from experience Kolb's Learning Style Inventory, KLSI 4.0, (kolb, A.Y, 2005). Each learning style reflects individual preferences in terms of knowledge acquisition and information processing. We adopted Kolb's convergent learning model to guide our approach because it is the most dominant model in our sample. It is with this in mind that this study focuses on exploring the potential applications of artificial intelligence (AI) to meet the needs of students with a convergent learning style, as defined by Kolb's model. These learners are characterized by a preference for modeling phenomena, data visualization or even the design of virtual experiences (Kolb, D. A. 1984).

However, our experimental work consists of carrying out a survey among physics and mathematics options students of convergent style, to identify the most common problems encountered in learning physics, then to propose a test in which the convergent students express their preferences for AI-based activities proposed on a LIKERT scale, the results were very encouraging, then we analyzed how its AI technologies could respond to these issues, based on a review of the literature. These experiments allowed us to evaluate the impact of these solutions on students' understanding and their engagement with the subject. Finally, we refined our proposals based on the feedback collected to arrive at concrete recommendations. This research aims to demonstrate the potential of AI to enrich the learning of physics in high school and open the way to new innovative educational approaches. The results obtained will allow us to better understand how to take advantage of these technologies in an effective and relevant manner in an educational context.

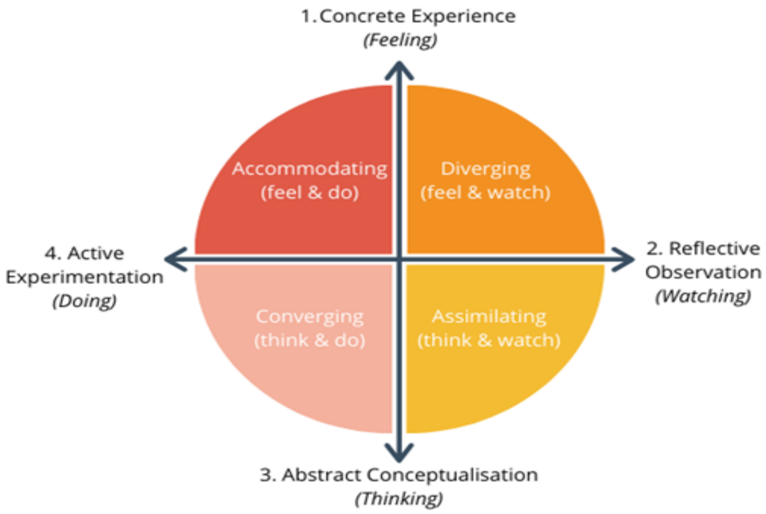
LITERATURE REVIEW

To structure the theoretical framework of this study on the use of artificial intelligence (AI) in the teaching of physics to students with a convergent learning style, we can rely on the following key elements:

Kolb's experiential learning model

Developed by David Kolb, the experiential model offers a theory of learning based on experience. It suggests that individuals develop preferences for certain stages of the cycle, concrete experience, reflective observation, abstract conceptualization and active experimentation, leading to four distinct learning styles: divergent, assimilative, convergent, accommodative. (Kolb, 1984), presented in the Following figure:

Figure 1: kolb Learning cycle.



(https://eduolog.com/wp-content/uploads/2021/06/Kolb-Learning-Cycle.png)

This Kolb model of experiential learning, and more specifically the characteristics of convergent learners, constitutes a key element of the theoretical framework of this study on the use of AI in physics education, according to Felder, R. M., & Silverman, L. K. (1988), convergent style students show preferences for:

- Active experimentation and practical application of concepts.
- Problem solving, decision making and modeling of phenomena. They are more interested in using knowledge to find solutions than in theoretical thinking.
- Activities that allow them to put their knowledge into practice and test their hypotheses, and are often attracted to technical, scientific and engineering-related fields.

Kolb and AI Learning Styles

According to, Al-Samarraie, H., & Saeed, N. (2019). AI can adapt to each of these learning styles to provide optimized learning experiences. The integration of artificial intelligence (AI) in the learning of physics for high school students, who benefit from an educational approach adapted to their individual needs, opens up new perspectives and provides them with:

- More personalized learning experiences tailored to their individual needs, thanks to AI-based systems (interactive simulations, personalized feedback, tailor-made resources) that analyze the performance and learning preferences of each student. This allows students to explore and understand physics concepts in a more effective and engaging way (Papanikolaou, K. A., et al, 2003).
- Targeted resources and activities to strengthen their understanding of physical concepts. This allows students to progress at their own pace and address their specific gaps.

This AI-based approach transforms learning physics into a personalized and dynamic experience for high school students...(Basu, A., 2013).

Kolb's style inventory

Kolb's Learning Style Inventory, a widely used tool for identifying students' learning preferences, is based on the experiential learning model developed by David Kolb. It identifies four main learning styles: Divergent, Assimilative, Convergent and Accommodative. This inventory makes it possible to identify the strengths and learning preferences of each individual, in order to design more effective learning experiences adapted to their needs. Identifying Kolb's learning style is particularly relevant for designing AI-enriched online learning activities, focusing on the most appropriate approaches for each style, (Kolb, D. A. 1984).

Benefits of AI Integration

AI can offer advanced modeling and simulation tools, used to create interactive virtual simulations and models that allow students to explore complex physical phenomena, (Mahligawati, F et al, 2023) facilitating the analysis of complex data, enable interactive virtual experiments, machine learning algorithms can be used to analyze laboratory data, develop models and help students draw meaningful conclusions from their experiments,(Andreja Istenič Starčič, ,2019), or even provide intelligent tutoring systems to help students with their learning. This could provide additional explanations, suggest practical exercises and even adjust their teaching approach according to each student's learning style(Mousavinasab, E.,2021), adaptive learning platforms using AI to personalize the learning experience of students based on their needs and performance. These platforms can recommend additional resources, adapt the level of difficulty of exercises or offer personalized learning paths for each student (Alqahtani, R.et al, 2021). Collaboration and group learning by providing tools to communicate and share resources on physics projects, share ideas and benefit from the collective knowledge of the group, (Huijuan Fu, et al, 2013). with prototypes of artificial intelligence (AI) tools integrating the main functionalities identified as relevant to meet the needs of convergent learners in the teaching and learning of physics :

- Advanced physical phenomena simulator: This prototype AI-based simulator would allow students to visualize and interact with detailed digital models of complex physical phenomena and faithfully reproduce the laws of physics with an interactive 3D visualization interface and intuitive, allowing the manipulation of variables
- Conversational virtual assistant for science learning, designed to support students in their science learning in a personalized way with an explanation of concepts in a way adapted to the learner's level and preferences and monitoring of student progress and recommendation of activities.
- Intelligent assessment and diagnosis system: This prototype AI tool would make it possible to analyze student performance and shortcomings in real time in order to offer them personalized learning, with identification of areas requiring reinforcement for each student through appropriate remediation and deepening activities

These AI tool prototypes would integrate key functionalities identified as relevant to meet the specific needs of convergent learners.

Converges and AI applications

For learners with a convergent learning style, who favor learning activities focused on problem solving in terms of applications of artificial intelligence:

- Case studies and interactive simulation: Allow learners to interact with AI-based simulations to test solutions
- AI-guided problem-solving systems: Help learners analyze problems, generate potential solutions and evaluate their effectiveness, and provide personalized feedback using machine learning

The goal is to provide convergent learners with activities that allow them to explore, analyze and solve problems interactively, while benefiting from the support and capabilities of artificial intelligence.

Features and characteristics of artificial intelligence (AI) solutions

Sak, R. (2018), in his article addresses the needs of students with a convergent learning style, who can be considered gifted learners. the main functionalities and characteristics of AI solutions, the most relevant to meet the needs of convergent learners in secondary school physics learning:

- Advanced modeling and visualization: It presents the ability to create detailed and realistic digital models of complex physical phenomena, the possibility of visualizing these models in 3D in an interactive and immersive way, in order to allow students to explore and interact with these visual representations, (Tanya Gupta et al, 2022)
- Dynamic and interactive simulations: This is the design of realistic simulations allowing the manipulation of variables and parameters, for students and the possibility of testing hypotheses and observing the consequences in real time, in order to promote experiential learning and the practical application of the concepts. (Sophia Maier et al. 2022).
- Intelligent tutorial systems: This is the ability to analyze students' problem-solving strategies and provide cues, explanations and feedback tailored to individual needs, in order to develop problem-solving skills in convergent learners. (Samantha Johnson et al, 2022)
- Intelligent assessment and diagnostic tools: Real-time analysis of student performance and gaps, and identification of areas requiring reinforcement for convergent learners and customization of remediation and deepening activities. (Jian Li ,2023)
- Content and activity recommendation systems: Suggestions for resources, practical experiences and applications relevant to convergent learners, and take into account student preferences, performance and learning styles, in order to promote engagement and motivation of convergent learners. (Emily Zhao, David Moreno, Jessica Huang,2022)

These functionalities and characteristics of AI solutions would help meet the specific needs of convergent learners by promoting active learning, practical application of knowledge, development of problem-solving skills and autonomy in learning.

RESEARCH METHODS

Given the topic of the study, which focuses on exploring the potential of artificial intelligence (AI) technologies to meet the needs of students with Kolb's convergent learning style in physics, it is likely mixed type research, combining quantitative and qualitative approaches.

Context and research problem

The physics module of the Mathematics Sciences A, B and Physics section of the high school is organized around four fundamental parts of physics presented over two semesters: waves, nuclear transformations, electricity and mechanics with a working time of 118 hours , it allows the maintenance of fundamental knowledge. basic concepts and notions. (High school programs qualifying as "official guidelines from the Department of Education"),[37]. After presenting the sample of 85 high school students combined on the three options: (2SMA, 2SMB, 2SPys).

Data gathering

The approach consists of accumulating disconcerting information on learners' preferences in terms of learning activities according to Kolb's convergent style, through the following steps:

First, an online questionnaire (ILS), which presents the Kolb Learning Style Inventory, is used to assign each student's dominant style.
Second, a survey aimed at identifying the difficulties encountered by high school students and their physics teachers, collecting information on the percentage of dissatisfaction with these factors according to a Likert scale, and presenting the most common problems encountered in the teaching and learning of physics, namely:

- Education language ,
- course content overload,
- the absence or forgetting of prior knowledge,
- lack of in-depth understanding of abstract concepts of physics,
- lack of tutoring and practical work,
- inconsistencies between the mathematical tools learned in mathematics and those used in physics.
- teacher-centered teaching,

Finally, students are asked to carefully complete a test that presents their degree of preference for the proposed learning activities, which present solutions based on applications of artificial intelligence, such as: interactive presentations, problem solving , guided discussions. ...all aimed at improving the teaching and learning of physics in high school. Its activities were chosen according to precise criteria, and we also relied on a body of previous research (Cheng, M. T., Lin, Y. P., & Lin, S. S. J. 2013, Hmelo-Silver, C. E, 2004, Kuhn, D ., & Hemberger, L. 2014, Almpanis, T. and Kynigos, C. 2010, Linn, MC, Davis, EA and Bell, P. 2004). The results were processed in Excel with their corresponding graphs, and the analysis was carried out using SPSS software for advanced statistical analysis, on the preferences to the convergent style of the activities designed by the AI to carry them out.

RESULTS AND DISCUSSION

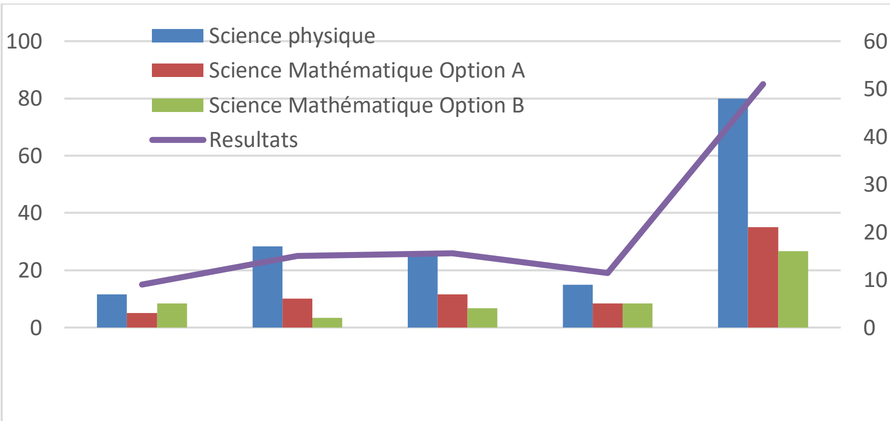
Learning Styles

he results of our samples are summarized in the following table:

Table 1: Learning styles according to sample options

Styles	Physical Science	Science Mathematics A	Science Mathematics B	The Somme	%
Divergent	7	3	5	15	17,64
Assimilators	17	6	2	25	29,41
Convergents	15	7	4	26	30,58
Accommodators	9	5	5	19	22,35
The Somme	48	21	19	85	100

Figure 2: Representation of each style according to kolb



According to the analysis of Figure 2, which represents the distribution of the 85 students according to Kolb's style:

- 18% of the sample are divergent learners
- 29% of the sample are assimilators
- 31% convergent style
- 22% of the sample is accommodating

According to Figure 1, we see that students in physical sciences are more assimilators who tend towards theory and like to synthesize and propose theoretical solutions to problems, which justifies their orientation towards experimental sciences. The Mathematical Sciences A option, on the other hand, presents almost the same convergent and assimilative styles, which proves that the latter tend towards theory, logic and the application of theoretical concepts, justifying the official orientations which present these students as theorists. For Mathematical Sciences Option B, on the other hand, accommodating and divergent styles are the most dominant, justifying the orientation of these students towards experimentation and observation, and proposing hypotheses that characterize technical education based on skills practice.

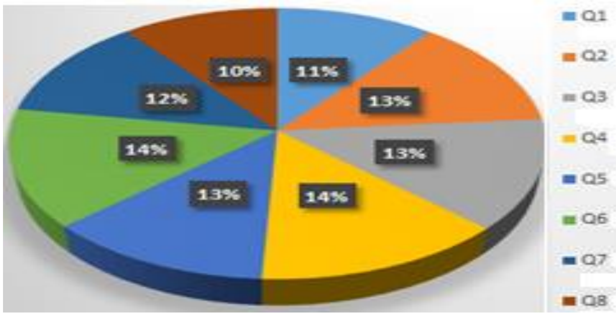
Presentation of the difficulties encountered

The presentation of the difficulties encountered by high school students and their teachers in learning physics, detailed in the following table:

Table 2: The number of learners who responded to the proposals and their percentages

the sample of 85 students is distributed as flows		
Prepositions	Number of learners who responded: yes out of 85 students	%
Q1:The concepts of physics are abstract and is there a deep understanding?	63	74,12%
Q2: Is the language of instruction an obstacle?	78	91,76%
Q3: Is forgetting previous knowledge a factor in learning physics?	80	94,12%
Q4: Course content overload, presenting a problem?	83	97,65%
Q5: Is there a shortage of TDs?	75	88,24%
Q6: Is there a TP Insufficiency?	85	100%
Q7:Is teaching centered on the teacher and dominated by exposure?	72	84,71%
Q8:Are the mathematical tools used in physics difficult?	62	72,94%

Figure 3: the percentages of difficulties proposed by the students.

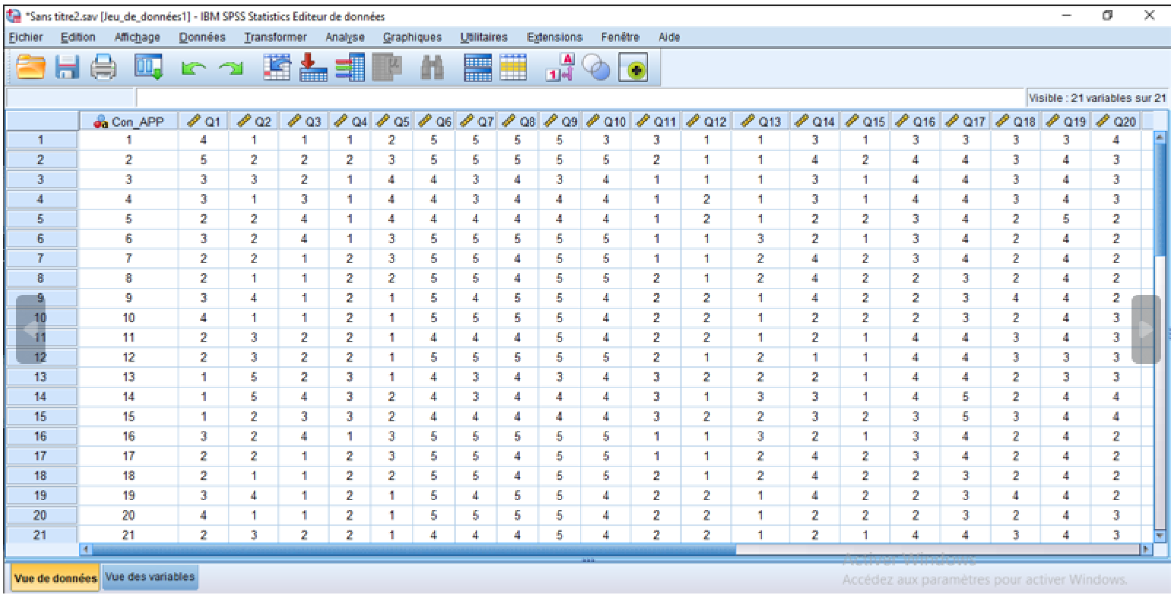


Assessment of physics learning difficulties

The survey carried out to assess the difficulties expressed by High School students in learning physics aims to identify the difficulties encountered by High School students and their physics teachers, according to the results recalled and represented in Figures 2 and 3, the collection of dismaying information on the percentage of dissatisfaction of its factors according to a Likert scale in Table 2, and which present the most encountered problems in the teaching and learning of physics means that there are real problems expressed by his students:

- Table 2: represents the percentages of difficulties proposed by the students within a margin of 10% to 14%, meaning that there is consistency in these responses.
- Figure 3: the distribution of problems according to dissatisfaction with the difficulties encountered in physics, according to the figure the proposition Q6 represents 100%, all the students have a lack of practical work, and that 72.94% represents the proposition Q8 which designates the coherence of the mathematical tools used in physics and their difficulties, this is due to the mathematical aspect of the students, this problem will be alleviated by collaboration between teachers, whether physics or mathematics.

Measuring the reliability of activity preferences according to convergent style



	Con_APP	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
1	1	4	1	1	1	2	5	5	5	5	3	3	1	1	3	1	3	3	3	3	4
2	2	5	2	2	2	3	5	5	5	5	5	2	1	1	4	2	4	4	3	4	3
3	3	3	3	2	1	4	4	3	4	3	4	1	1	1	3	1	4	4	3	4	3
4	4	3	1	3	1	4	4	3	4	4	4	1	2	1	3	1	4	4	3	4	3
5	5	2	2	4	1	4	4	4	4	4	4	1	2	1	2	2	3	4	2	5	2
6	6	3	2	4	1	3	5	5	5	5	5	1	1	3	2	1	3	4	2	4	2
7	7	2	2	1	2	3	5	5	4	5	5	1	1	2	4	2	3	4	2	4	2
8	8	2	1	1	2	2	5	5	4	5	5	2	1	2	4	2	2	3	2	4	2
9	9	3	4	1	2	1	5	4	5	5	4	2	2	1	4	2	2	3	4	4	2
10	10	4	1	1	2	1	5	5	5	5	4	2	2	1	2	2	2	3	2	4	3
11	11	2	3	2	2	1	4	4	4	5	4	2	2	1	2	1	4	4	3	4	3
12	12	2	3	2	2	1	5	5	5	5	5	2	1	2	1	1	4	4	3	3	3
13	13	1	5	2	3	1	4	3	4	3	4	3	2	2	2	1	4	4	2	3	3
14	14	1	5	4	3	2	4	3	4	4	4	3	1	3	3	1	4	5	2	4	4
15	15	1	2	3	3	2	4	4	4	4	4	3	2	2	3	2	3	5	3	4	4
16	16	3	2	4	1	3	5	5	5	5	5	1	1	3	2	1	3	4	2	4	2
17	17	2	2	1	2	3	5	5	4	5	5	1	1	2	4	2	3	4	2	4	2
18	18	2	1	1	2	2	5	5	4	5	5	2	1	2	4	2	2	3	2	4	2
19	19	3	4	1	2	1	5	4	5	5	4	2	2	1	4	2	2	3	4	4	2
20	20	4	1	1	2	1	5	5	5	5	4	2	2	1	2	2	2	3	2	4	3
21	21	2	3	2	2	1	4	4	4	5	4	2	2	1	2	1	4	4	3	4	3

Tables Multiple Response

$Divergent Style Frequencies

		Responses		Percent of Cases
		N	Percent	
Divergent Style[a]	Very weak	37	45,1%	148,0%
	Weak	45	54,9%	180,0%
Total		82	100,0%	328,0%

$Convergent_Style Frequencies

		Responses		Percent of Cases
		N	Percent	
Assimilator Style[a]	Average	11	8,8%	44,0%
	Good	54	43,2%	216,0%
	Very good	60	48,0%	240,0%
Total		125	100,0%	500,0%

$Assimilator_Style Frequencies

		Responses		Percent of
		N	Percent	Cases
Convergent Style[a]	Very Weak	46	36,8%	184,0%
	Weak	54	43,2%	216,0%
	Average	18	14,4%	72,0%
	Good	7	5,6%	28,0%
Total		125	100,0%	500,0%

$Accommodator_Style Frequencies

		Responses		Percent of
		N	Percent	Cases
Style Accommodator[a]	Weak	28	100,0%	186,7%
Total		28	100,0%	186,7%

Measure the reliability of activity preferences according to the convergent style :

According to the questionnaire proposed in Table 2, the cumulative results are processed by the SPSS statistical analysis software for its variables which are of ordinal qualitative type, the analysis was carried out on the numbers and the crossing of multiple responses, but before Therefore, a measure of test reliability is necessary to measure the degree of consistency between the 5 items on a sample of 26 convergent students.

- Measurement of test reliability:

Statistical index varying between 0 and 1 which makes it possible to evaluate the homogeneity (the consistency or internal coherence) of the questionnaire composed by a set of items. In practice, we generally consider that the homogeneity of the instrument is satisfactory when the value of the coefficient is at least equal to 0.70, while our items for the divergent are acceptable with a coefficient of 0.836.

- Frequency analysis :

The measurement of frequency is done by a cross-tabulation or groups the items to give rise to the dominant style, the results are interpreted as follows:

- Divergent style frequencies: The table shows the satisfaction rate with the divergent style, that 82 students expressed a satisfaction of very low and low, with a percentage of 99%, which allows us to say that these students have a different tendency than that of the as - simulators.
- Style assimilation frequencies: According to the results of the 25 assimilators in our sample: 91% good and very good, 8.8% average. This group of assimilators has a satisfaction rate for this style of This can be judged as not having a perfect style, but a spectrum or one is dominant,
- Converging frequency style: According to the results of our sample: 80% poor and very poor, 14.4% average and 5.6% good. This group converges at a satisfaction

rate for the convergent style of 5.6%. This may justify an increase in the application score for assimilators.

- Style Accommodation Frequencies: According to the results, this group of assimilators has a higher rate of dissatisfaction with the accommodating style, which can justify why assimilators tend more towards converges than towards accommodators.

Challenges and considerations

Challenges and considerations for integrating AI tools into high school physics teaching. May include the use of AI tools requiring adequate IT infrastructure, including computers and reliable internet connectivity. Integrating these tools requires careful planning, teacher training, selection of appropriate tools, and ongoing assessment, (Lynch, C. et al, 2019). The main objective is to ensure that the use of AI supports learning objectives and improves the learning experience of students. It is essential to ensure that students and teachers have access to the resources they need to use AI tools seamlessly. Teachers need to be trained in the use of AI tools and how to effectively integrate these tools into their physics lessons, as they need to understand the basic concepts of AI and be able to guide students in their learning and select those that are adapted to the context. specific needs of high school physics courses and programs. Tools should be aligned with learning objectives and offer relevant functionality to help students understand and apply physics concepts, allowing activities to be planned and designed that seamlessly integrate AI tools and to assess student learning when they use these tools (Luckin, R., & Holmes, W. 2016).

CONCLUSION

Artificial intelligence offers promising prospects for simplifying physics and revolutionizing our understanding of science. By combining AI and physics, we can improve our learning and exploration of this fundamental discipline. The use of artificial intelligence in physics has many benefits. It enhances the learning experience by providing personalized assistance to students and deepening their understanding of complex physics concepts. A concrete example of the use of AI in physics education is the physics chatbot. This type of AI-powered tool provides students with instant feedback, answers to their questions and support in their physics studies at school and university. What's more, AI is also finding its way into preparatory math's and physics classes at big schools. It helps students solve complex physics problems, provides simulations, and supports their preparation for graduate studies in physics.

In short, artificial intelligence represents an exciting opportunity to simplify physics and advance our scientific understanding. By combining AI and physics, we can push back the boundaries of knowledge and open up new perspectives for research and learning in this essential area of science.

In conclusion, the integration of artificial intelligence (AI) into physics education offers many opportunities to enhance student learning and experience. Studies and research in this field have highlighted the potential benefits of AI, such as personalizing learning, improving student engagement and providing access to tailored teaching resources.

However, it is important to address certain challenges and key considerations. Teacher training is crucial to enable the effective use of AI in physics lessons. Teachers need to understand the fundamental concepts of AI and be able to integrate AI tools in a relevant and appropriate way.

Future research should focus on thoroughly evaluating the effectiveness of AI in physics education, measuring student progress and comparing results with traditional teaching methods. In addition, it is essential to develop specialized AI tools for physics, such as simulators, machine learning models, that meet the specific needs of this field.

Finally, interdisciplinary collaboration between education experts, AI researchers and physics teachers is essential for the successful design and implementation of AI tools. By working together, it is possible to maximize the benefits of AI in physics education and create more effective and engaging learning environments for students. By following these recommendations and continuing to explore the possibilities offered by AI, we can pave the way for a new era of physics education, offering enriching learning experiences and preparing students for the challenges and opportunities of the modern world.

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