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ORIGINAL ARTICLE

Teachers' views on incorporating ChatGPT in science teaching

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ABSTRACT

Objective: The new development in the area of Artificial Intelligence (AI) education has raised interest with a sense of urgency about further refining it in the area of science education. Method: The qualitative study provides an insight into views of science teachers about the potential and limitation of employing ChatGPT in science education and how to take advantage of such technology-based developments. Methods: The research was conducted based on 46 science teachers of Zanjan province, using the snowball sampling method. Results: The teachers gave feedback on how ChatGPT can be beneficial and restrictive as an effective educational tool for their classroom. Overall, findings paint a picture where even though the teachers openly acknowledged that ChatGPT is full of potential to make so much space for interaction, they were still concerned about the impact of the technology, for instance, making too much dependency on the technology among the learners and how the tools impede the capacity of the students in thinking critically and creatively. The results also support discussion of future Career development opportunities with responsive curricula redesign for the sake of leveraging the possibilities of AI tools in an effort to support learning. Practice and policy implications and directions for research on the career development opportunities are considered in the conclusion and limitations of the study. Conclusion: .This study adds to the growing field of education and AI by highlighting the need to balance innovation with pedagogical responsibility. It shows that AI can enhance teaching as a supportive tool, not a replacement. Successful integration requires attention to equity, ethics, and collaboration among educators, policymakers, and technologists.

KEYWORDS

ChatGPT, Science teaching, Teachers' views, Artificial intelligence, Technology, Designing curriculum, Teaching methods

EXTENDED ABSTRACT

Introduction

The education terrain is being transformed fundamentally in keeping with the accelerated pace of change of the 21st century, with technological innovation at the fore (Bertocchi & Spagat, 2004). Science education has been part of several other alternative education paradigms that have driven the revolution. Incorporating tried and tested methods and technology provides novel benefits but new challenges intrinsic to these changes. There is no one technology, ChatGPT, to which there is a shift towards unprecedented results and to redefine the traditional model tasks in students within a K -12 setting. The potential of ChatGPT suggests more than simplistic support, and those capabilities offer new and creative possibilities to customize learning to student experience. But embedding this new technology within education systems and settings will generate fundamental questions about its effectiveness. How well can ChatGPT be utilized in the old classroom? What specifically will ChatGPT offer that is so new and what are the dangers of using ChatGPT? What do educators, with highly diverse education degrees and experience, do as they navigate the deployment of this new and new technology tool harnessing technology into their teaching?

Although the technological competence of ChatGPT has been widely tested, its application as an educational aid in science has yet to be tested globally. Teachers, as key stakeholders and decision-makers of education, possess crucial insights of using ChatGPT in educating science. But those presumptions of teachers across various global contexts await to be widely examined. That is part of the larger problem of scaling ChatGPT up for application in science teaching on a practical and large scale. Without that data, it is difficult to think about how to integrate the worth of existing pedagogical practice with a new generation of technology. This article attempts to make sense around that issue by looking at the significance of applying ChatGPT as an educational tool in science for application in conventional classrooms. The study answers teachers' perceived affordance and limitation of employing ChatGPT and its future implications on science teaching. The study sought to gather the opinions of science teachers across various contexts in order to build an equitable pedagogy model that leverages the strengths of building practices and the potential of technology. To achieve this, the study raised the following major questions:

1. What would science teachers of multicultural global learning settings like to learn about the potential benefits of using ChatGPT in the classroom?
2. What are limitations on the use of ChatGPT for teaching science?
3. What would science teachers prefer for future science instruction as a result of the innovation of ChatGPT and what needs to be rewritten to facilitate this innovation**?**

Literature review

There was a complete revolution of the 21st-century revolution of science and technology. Science content and teaching on exponentially larger scales and education on a universal scale were introduced into web-based learning environments (Meisuri et al., 2023). Adaptive, gamified, and adaptive learning processes in new apps also revolutionized the traditional pedagogical process simultaneously (Fleischmann, 2016). These new learning environments have seen the AI technology such as ChatGPT at the center of some of the most groundbreaking innovations with the potential to reshape teaching and learning practice. The threat of being replaced by default pedagogical forms and personalized provision, such as that offered by Kamalov and others, has put AI in the spotlight in education today. One of the most interesting aspects of ChatGPT is that they can personalize learning and teaching.

Through the ability to segment the individual vulnerabilities from the strengths of each learner, AI software can potentially craft best-fit solutions that are customized to meet the specific needs of each student individually, thus offering denser interactions and understanding (Nomerovska, 2023). Within scientific education, ChatGPT illustrates the same with scope for context-dependent feedback in real time not just to guide misconduct but to induce students into condemning themselves on their scientific thought process. Such real-time discussion allows students to have a sense of sensitivity for subtle differences, context sensitivities, and rich interplay in scientific

concepts (R. Lewis, 2024). Venter et al. (2024) also recognize that such feedback loops facilitate cognitive recall and self-awareness and allow students to talk more and learn at their own pace towards scientific competence. Personalization is the key to science teaching, attuned to the many needs, histories, and purposes of the learners. Normal school cannot do that diversity in the majority of the cases and offers the students very general learning, which would be inappropriate for all the students. Apart from being dynamic, ChatGPT is also a component of the solution of more personalized learning in an attempt to find the ultimate middle ground where no subject would ever be too difficult or too boring for any learner. Misra and Li (2024) explained that applying ChatGPT in an achievement learning class resulted in more effective interaction on the part of the students and quantifiable improvement in recollection and utilization. Flexibility keeps students engaged because they relentlessly move forward. Apart from such worthwhile benefits, there are certain genuine problems in the application of ChatGPT for science education. Powell and Courchesne (2024) use calibration issues to calibrate ChatGPT's dynamic conversation capability to standard curricular levels. Science lessons are evidently crafted to present some type of learning experiences, pedagogically prepared and by environmental factors. Calibration on the manner in which one approaches managing balancing a facilitator as dynamic as ChatGPT must be determined so that feedback loops and trade are maximally balanced to overall teaching objectives.

A balance among them cannot be ensured with pedagogical competency and technological competency such that ChatGPT enhances and is not infringing upon curricular objectives. Use of AI tools also has with it necessary education equity issues. Afzal, Khan, Daud, and Ahmed (2023) touch on the digital divide, i.e., sociocultural and technologic apprehensions. More technology or less digital competence in some fields might actually empower technologies like ChatGPT to have opportunities to fill existing gaps with higher probabilities. Such gaps would need infrastructure and human resource development programs to a point where their accessibility and utilization are on par. Teacher disposition will be essential towards trying to demy-thologize AI adoption complexity in science teaching. Teachers who are from diverse backgrounds—i.e., teachers who are from diverse cities in the Zanjan province—are the ones most likely to determine the future of science education by adopting the utilization of ChatGPT. Attitude is the promise, but also the boundary, of utilizing ChatGPT in teaching. For example, for example, Purnama et al. (2023) illustrate the application of ChatGPT in providing complementary assistance to struggling students by directing them to required resources or explanatory directives. Proper use of ChatGPT, however, entails tightrope-walking between logistically necessary modifications and pedagogical objectives and students' learning needs.

To their credit, Sundkvist and Kulset (2024) define the following student types in their uptake and utilization of ChatGPT, viz. convenience, trust, preference for technology, and peer social pressures. These types of students having been exposed to ChatGPT will utilize it to learn for study purposes, i.e., for providing answers for a course as against exam study. Although most of them are aware of the ChatGPT response limitation, hardly any of them perceive its use negatively influencing learning. The above findings confirm the necessity of developing digital competence and criticality in a bid to utilize ChatGPT suitably on the part of students. Though subsequent studies have already begun exploring the use of ChatGPT in science education, there has been no serious study yet. Other research has been satisfied to merely report anecdotal findings and thus left a huge gap in our understanding of its overall influence on class discussion, course structure, and instruction.

To rectify this, additional and systematic research must be carried out in a manner to consider the problems and likely limitations of large-scale implementation of AI in science education. As per Koraishi (2023), its new technology can best position itself in a paradigm shift of traditional pedagogy, compelling teachers to walk a thin line between pedagogical intention and technological advancement. Overall, more enthusiasm for ChatGPT and its application in science education is cause for hope and cause for concern. For as groundbreaking as it appears, its adoption must

take into account its effect on teaching and learning. By putting a strong emphasis on learner and teacher experience and expertise, we can optimize not only learning outcome but in line with basic pedagogical principles. With more to come in the future, more scientific studies, there will be increasingly more studies documenting the function of ChatGPT and having an objective composite picture of its influence. The main objective of this study is to investigate science teachers' perceptions of the affordances and limitations of integrating ChatGPT as an educational tool in traditional K-12 science classrooms across multicultural and global educational contexts. By exploring teachers' perspectives, this research aims to identify potential benefits, challenges, and necessary adaptations for future science instruction that effectively incorporates AI-driven technologies like ChatGPT. Ultimately, the study seeks to contribute to developing an equitable, technology-enhanced pedagogical model that aligns with evolving educational needs and supports personalized, student-centered science learning.

Research Design

Qualitative research design was employed in the current study to explore and reflect science teachers' rich beliefs and experiences while teaching science using ChatGPT. Qualitative research is also known as rich and flexible to interpret, thus more accessible to researchers to study participants' accounts, problems, and motivations in rich depth (George, 2021). This method was employed in an attempt to capture rich interaction between peripheral AI technology and mainstream science pedagogy. Insofar as it is experiential in nature, qualitative research permits tracking of emerging trends and patterns and rich, textured accounts of how technology such as AI-powered tools such as ChatGPT interacts with mainstream teaching practice.

Participants

46 science teachers at the provincial level in Zanjan participated in the study who were intentionally hired to increase heterogeneity for the variables years of experience, educational degree, and professionalism.

They included a variety of participants ranging from novice to experienced teachers, whose views provided an appropriate mix of experience. The data collection approach employed in research was snowball sampling, which was most appropriate for qualitative research that aimed for depth and not breadth (Katz, 2015). Although the sample is small to conduct quantitative analysis, it is sufficient to perform qualitative analysis with focus on exploratory in-depth analysis instead of statistical generalizability. Demographic Breakdown

- Age profile of the participants is shown as Table 1 below:
- Age Profile: 43.4% are between the ages 36–45 and 23.9% are between the age groups 46–55.
- Gender Profile: 56.52% females were part of the sample that represented a fairly balanced gender mix.
- Level of Education: They were predominantly (65.21%) PhD holders, reflective of the level of education that attended the participant's level.
- Academia Rank: The largest percentage were Assistant Professors (32.6%), of which 26.08% were Lecturers.
- Years of Experience Teaching: 56.52% of participants had 11–20 years' experience, followed by 15.21% with 1–10 years and 15.21% with more than 20 years' experience.

Self-Reported ChatGPT Experience

This self-reporting experience is as follows:

- Intermediate Level: 50% of the students reported that they were at the intermediate level.
- Advanced Level: The interviewees who placed themselves in the advanced users category with high capability level and high usage accounted for about 37% of the total.
- Beginner Level: 8.7% fewer percentage who were beginners.
- Expert Level: Only 4.3% identified themselves as experts.

The various levels of ability need to be taken into account when computing participants' ratings and engagement with the AI tool. Participant self-categorization of ChatGPT ability can, in certain instances, mirror perceived v. actual abilities differences. This was met with

clear and specific instructions used in an effort to have participants rate their ability with an open-ended instruction. As per Paulhus and Vazire (2007), self-report scales respond to the self-esteem and the level of the abilities of the participants.

For instance, using teachers at different levels of education is used to provide an overall impact of ChatGPT on teaching. This makes the research stronger to become representative in a bid to make it more inclusive by giving qualitative information about teachers' attitudes towards the use of ChatGPT for science teaching. The research relies on qualitative depth and richness as opposed to quantitative metrics in an effort to understand the intangible effects of using AI learning tools. This model leaves space for in-depth investigation of the promise and limitations of applying ChatGPT in science education. The qualitative findings below suggest the transfigurative promise of artificial intelligence for learning that demands evidence-informed, context-specific practice.

Table 1. Information of the participants

Variations		Regularity	Percentage
Gender	Male	20	43.47
	Female	26	56.52
Age	25_35	5	10.8
	36_45	20	43.4
	46_55	11	23.9
	More than 55	10	21.7
Proficiency	Bachelor's Degree	29	15.21
	Master's Degree	14	19.56
	PhD Degree	3	65.21
Academic state	T	6	8.69
	L	11	26.08
	Assistant P	20	32.60
	Associate P	7	15.21
	FP	2	17.39
Teaching experience	1_10	7	15.21
	11_20	26	56.52
	More then 20	13	28.26
Total		**46**	**100**

Instrument

Questionnaire is employed in this research to gather lengthy and unstructured response from the science teachers. There was room for respondents' opinion, experience, and attitude towards the use of ChatGPT as a pedagogical tool in science teaching without confining them to close-ended and structured responses. Qualitative analysis would involve the use of highly open-ended tools over a wide variety of possibilities because it has the ability to retrieve deep lost information through very structured survey tool instruments (Patton, 2015). The questionnaire contained two sections:

1. Demographic Information:

2. Demographic information of the respondents from part one of the questionnaire was used in the utilization of contextual information in understanding perceptions.

It provided information on age, sex, level of education, geographical area, and cultural orientation. It also indicated the occupation, education level, and number of years of teaching experience of the respondent. Variables were employed as a means of explaining the effect of personal factors on attitude in the adoption of new technology like ChatGPT. For example, the level of education or teacher culture that determines their attitude towards the use of AI in schools. 3. Open-Ended Questions: 4. Six open-ended questions were asked in the latter part of the survey with an attempt to produce rich synergy of adoption of ChatGPT for learning science. The questions were designed also to get the participants reflecting on the experience, place things in context, consider the setting, and

to draw probable conclusions regarding the utilization of AI assistance and processes with traditional pedagogy.

Open-ended questions were employed in a bid to capture the picture of promise and risk that characterizes the application of ChatGPT in science teaching. The varied response of the teachers with different explanations was intended to capture the picture of AI as an explanation source and pedagogy tool for science teaching to possibilities of its application in learning and teaching in the future years.

Content Validity of the Questionnaire

To obtain content validity, a real expert stream was employed. Expert opinions were evoked when the experts were reading the instrument while performing as science instructors, authors of instructional materials about AI, and subject-matter experts in such topics as ChatGPT. These experts provided reflective remarks in the form of building guiding questions for providing richness and depthness in exploring the application of ChatGPT as a tool of learning science pedagogy pedagogy pedagogy teaching teaching in the best manner it could be taught. These experts were to provide suggestions and recommendations and suggestions and recommendations and reimagined in a state of spiritness, relevancy, and wholeness of questions. Along with this, even five research-based teachers who are not from science were conducted for pilot study. Not only were they subjected to completion of the questionnaire but even illustrated back on the way one would have to proceed with the construction and interpretation of the same. Few changes were made to such an extent that final draft was ready for publication to a specified group of people.

Data Collection Process

As was specified in the reporting of the research, the questionnaire was distributed among science teachers in the Zanjan province and a deadline for its answer was provided so that the collected data were ordered and timely; based on this distribution method it was possible to collect reliable and representative data between teachers from different geographical locations.

Data Analysis

Open-ended questions are more difficult to analyse and the process of data analysis is iterative. In the present study all the responses were tabulated and arranged which were then read over many times to give the broad picture of what the information was saying. Demographic factors were quantified before the qualitative data was collected in order to provide the brief description of the characteristics of the respondents. (2). systematic coded to extract common themes and emotions among teacher feedback about teaching science using ChatGPT in selecting patterns, ideas, and perceptions that were repeatedly articulated in the feedback. (3). Reflexive give and take in analysis was employed, in that continuous checking of recurring themes as well as raw data was carried out to ensure consistency with teacher voice. Retention of the views of teachers' in the integrity and authenticity (e. g., in having a more-in-depth report on their experience, and view of their perceptions that were balanced) was implemented to ensure that analysis was carried out on rich qualitative data that participants reported. This qualitative analysis was useful in the literature on AI integration in science education. Ethical considerations Clearly, standards are high in this study and the study objectives have been made clear to the participants in order that they may give their free and voluntary informed consent. Note also that respondents' data/information that was collected and their privacy are protected securely in a way that does not reveal that respondents' data will be divulged. Since the purposes of survey research in this survey are to advance human dignity and rights, respondents are informed that their information and views will be treated with respect, that they will only be used for scientific purposes and that no one other than them will know what the result of feedback is.

Findings

In order to present the findings clearly, the findings chapter begins with background and characteristics of science teachers and then with the central argument of the study (which comes out in three general themes which each serve as a lens for investigating the themes, problems and opportunities associated with using ChatGPT in teaching science).

The first theme: the possibilities of ChatGPT

The most striking aspect of ChatGPT is that it provides instant responses, which allow people to learn faster. Students love it for giving them immediate replies, which allow them to realize their mistakes and learn quicker. One person even stated that ChatGPT has transformed the way they receive immediate feedback because of the speed and ease it provides. This is extremely useful to students who have to grasp things and ideas in the correct way. ChatGPT also has great fame because it suits different learning abilities and needs. If a person learns quickly, slowly, or has uneven learning experiences, ChatGPT suiting them takes care of the individual. This enables teachers to see different needs among their students as well as provide learners with the right information they need. It is like having a perfect teaching tool in their hands. ChatGPT gives a face to learning—it is functional, realistic, and rooted in real-life situations. Teachers like the way ChatGPT gives students concrete examples and situations about what they are learning in school so they can relate to it better. ChatGPT has an enormous amount of information, which it uses to build lessons on hard or boring topics and divide them into smaller, more manageable chunks. One of the teachers used ChatGPT to create a play that would assist students in practicing standing up against bullying, thus building confidence and communication. Another used science to become more interactive by creating an environment in which students could experiment, fail, and learn under supervision. ChatGPT fosters learning through practice and enables students to practice as if they were in a real situation. It is a component of education today, and teachers desire others to do the same to offer complete and adaptable learning environments. Merging ChatGPT with education has transformed the way assignments are being completed by offering continuous assistance. As a 24/7 study aid, ChatGPT is helping students at any given time, aside from the regular classroom hours. Its impact is enormous, not just as a program but as a study aid. Teachers have seen radical changes in students who use ChatGPT. It makes learning of difficult topics with long explanations easier, which benefits all students and not just the top ones. For example, a teacher in Zanjan found that some of the former introverted students started participating in class after receiving answers from ChatGPT. And, ChatGPT is excellent at idea generation before writing, triggering thought and imagination. Such a teacher-like skill and potential to encourage makes ChatGPT valuable, opening classroom space where students feel free to speak more. Building structure and analysis skills is among the finest methods of instruction in ChatGPT. A student used ChatGPT while writing essays, benefiting from the comment and augmented analysis, which improved their work. Aside from explanation, students use ChatGPT to create counterarguments in arguments, considering different viewpoints. This activity positions ChatGPT as a reliable guide in structuring and constructing students' thinking capabilities. Picking ChatGPT is embracing the peak of modern learning tools.

The second theme: Problems in applying ChatGPT in science education

There have been some concerns raised over the use of ChatGPT for learning science, in particular whether it is correct and can produce critical thinking. The computer can highly create scientific explanations and facts with speed, but studying science may not be in a need to employ the very same thing. Some teachers have found that ChatGPT gives sometimes inaccurate or simplified descriptions of complex science processes.

It "has a tendency to oversimplify and misrepresent giant scientific ideas," confuse students, and generate misinformation, one educator states.

This is especially difficult in the types of courses that are critical thinking-based, such as data interpretation of experiments or controversy in science. Based on one of the other instructors, science fundamentals like "hypothesis testing and data interpretation limits" are extremely human-instruction dependent. Similarly, critical examination of the moral aspects of scientific advancements or the history of scientific thought includes some reflectiveness and empathetic comprehension that no computer can offer. While ChatGPT can presumably be useful in tasks like the development of quizzes, content summarization, or step-by-step solutions, its weaknesses become apparent in being able to foster critical thinking and inquiry learning. These are the indications of quality science

education. Teachers agreed that while ChatGPT is a useful aid, it was not able to replace human contact and reflective concern that accompany the teaching of science. The technologically dependencies and the basic dependencies in science suggest the usefulness of ChatGPT as contradictory. Even as some of the features of ChatGPT like its knowledge range, user-friendliness, and instant response make it an interesting pedagogical tool, the same features are also likely to be the source of trouble for science education. There have been a few instances of complaints from teachers regarding the students' overdependence on the tool. This "over-reliance" on ChatGPT to provide the responses can be encouraged to replace students' self-learning problem-solving and critical thinking skills. While technology can be utilized to assist with learning, it is a vitally important part of the tenuous equation.

As was correctly pointed out by one of the instructors, what is necessary here is a balance in not allowing technology interfere with interpersonal interaction patterns in the classroom environment. By course, teaching science with ChatGPT does involve pedagogical expertise to be used as an added tool for better pedagogical practice and not as a replacement. Successful teaching and learning science is founded on imagination. But as teachers consider introducing ChatGPT as a component of science education, its use has been in doubt regarding whether it would steal away the students' imagination. It is rightly pointed out by one of the students that "some students started using ChatGPT as a crutch rather than a tool." There would be excessive dependence on AI-based solutions, which would not assist the students in presenting knowledge in their own words. Failure and setback in learning science have consequences that cut across all categories. Experienced teachers note that ChatGPT strives to encompass the entire gamut of environmental traits, indicating deep interaction with the complexity of science. ChatGPT teachers, who also portray themselves as veterans or experts, welcome the promise of imparting elementary scientific concepts. New teachers recommended the topic of using ChatGPT as an educational assistant in the classroom, while experienced teachers ridiculed the lack of subtlety in human touch through AI-aided science teaching. The foregoing reaction emphasizes the necessity of highly effective pedagogical strategies through the capabilities of ChatGPT to address the unique needs of a new breed of students and teachers.

The third theme: The future of science teaching with AI technologies

The application of AI, i.e., ChatGPT, in science education predicts a future and hybrid teaching landscape. The authors have shown good quality work.

As the science education world keeps on evolving so rapidly, educators are gradually beginning to embrace the prospects of incorporating AI tools like ChatGPT in the classroom. Attendees agreed that tools like ChatGPT will prove useful additional refuges in science teaching. But this does not signify the complete elimination of conventional pedagogies. It is only hoped that such innovation will supplement orthodox class adventures, not displace them. This was a battle one instructor charted out, highlighting the need to come up with a fair way of teaching science, by saying: "I envision ChatGPT and others like it becoming a part of blended learning approaches." This is a convergent future vision where human instructors collaborate with AI, rather than against it. It benefits the students by making them read on their own and at the same time deriving the advantages of conventional classroom interaction", thus spanning conventional and electronic science learning realms. Discussion was also dominated by the role played by AI shifting in the curriculum.

It was opined by one of the participants that "with the arrival of tools such as ChatGPT, pedagogy will have to focus more on blended learning, combining the traditional learning with strengths of AI." This would give rise to the necessity of redesigning curriculum with more technology-related courses focusing on "critical thinking and practical implementation." other teacher stating that "we go more depth of digital era," "more emphasis on blended learning" would become a necessity very soon. They note AI technology such as ChatGPT needing "curriculum development changes to incorporate more technology-based activities." Students will be put through trial learning by the use of AI to give immediate feedback and pseudo-scenario

scenarios, thus making the learning process more "adaptive and iterative." Learning AI has aimed at increased focus on the activities of teachers and adaptability. In particular, there has been a shift from just teaching students "what to learn" towards greater study of "how to learn." This would involve, one professor said, the cultivation of creativity, emotional intelligence, and cross-cultural understanding along with the incorporation of technology. Another professor spoke of remaking the need to educate cross-cultural communication and adaptability in the current technology age. The typical reaction of the participants was that there should be a sense that students would be made to realize that technology must be grasped as a facilitator of learning and need not be rendered so reliant on it. The outcry that AI tools like ChatGPT is raising for teaching science is proof enough of an envisioning of what the future holds. Teachers of varying academic background and technical skills demonstrate the possibility of AI to complement traditional pedagogy. Experienced researchers highlight the importance of AI in order to create dynamic, engaging learning environments and develop curricula that bring together digital innovations and tested modes of teaching.

This shared vision is one of an AI as a part of the learning ecosystem that enhances education with a combination of digital and analog methods to construct an integrated learning experience. Later generations of users of ChatGPT, however, view the initial complexity of the tool and complain more about support in trying to maximize use of it. The movement towards integrating AI into pedagogy is a sign of the shared faith that it has to offer to enrich conventional practices in order to guarantee that the advancement of science education is guided by various concepts and experience. The site used herein is a combination of the leading developed centers for the duration of study in efforts to combine pedagogical affordances and drawbacks as far as Chat GPT goes, alongside studying demographic differences affecting teachers' usage and perception of AI as a tool**.**

Table 2. Summary of findings and demographic effect on ChatGP incorporation in science teaching

Theme	Summary of Key and top findings	Influential Demographic
Theme 1: Educational opportunities for incorporating ChatGPT	Highlights the advantages of instant feedback, customized learning pathways, and improved engagement through contextual learning.	Differed by teaching experience, with more experienced educators viewing this technology as a helpful tool and other teachers are dependent on it.
Theme 2: Obstacles in implementing ChatGPT for science teaching.	Identifies challenges such as cultural sensitivity, excessive reliance and technological dependencies in science, less creativity, and the necessity of preparing for real-world situations.	Beginner learners, affected by their familiarity with ChatGPT, reported facing more challenges in implementation.
Theme 3: The development of science teaching of AI instruments	Discusses the potential for AI to increase traditional teaching methods use these technologies for redesigning curriculum	Younger teachers and those with advanced qualifications exhibited a greater willingness to incorporate AI tools into their pedagogy.

Discussion

The findings of this research on the impact of integrating ChatGPT into the learning process are truly fascinating. The classroom is not only where learners with an equal amount of learning capacity and capabilities are, but also a ground for students who have varying learning capacity, capabilities, thinking patterns, as well as various backgrounds. This is requesting a shift of the teachers and the education system itself to accommodate this diversification and accept it. In a different sense, it is requesting acceptance of differentiated and individualized education for everyone. There is research to indicate that for a pedagogy to be successful in placing profound and enduring knowledge within students, it must be suited to the learner's specific attributes. High-quality education is not a result of a generic methodology; it is a matter of placing pedagogical practice in the distinctive capabilities of learners (Heather C. Hill Mark Chin,2018).

ChatGPT has combined traditional means of instruction to accommodate personalized needs, offering a tailor-made process that caters to their unique attributes. In engaging with students, it builds a tailor-made learning process, serving as an electric model supporting the above-researched studies.

Scientific education cannot be strictly theoretical knowledge but has to achieve balance by adopting its application in everyday life (Johnston et al., 2019).

When the students apply what they have learned, they realize that scientific principles do work and enhance their own lives (Haryanto & Arty, 2019). With this awareness, curiosity emerges, and students begin experimenting and perhaps obtaining beneficial scientific results. But it is not easy to create such an efficient learning environment because there are numerous kinds of problems which are hindering the process of science learning from being carried out in the most efficient way possible. Some of those issues are described as follows:

One of the concerns that arose was that the students would overdepend on ChatGPT. There was concern about the negative consequences of too much technology use when acquiring science knowledge. The argument presented was that unreflective uptake could actually make students passive consumers of pre-packaged knowledge rather than active learners who construct their own learning.

Another issue that had been raised by the teachers was the capability of ChatGPT to apply scientific concepts and context-specific elements practically to its learning services.

The issue was built from the concept of science as a complex inquiry and knowledge system. As noted by current research, AI holds tremendous potential in scientific learning but with reservations regarding its capacity to mimic the intricacies of scientific practices and ethics sufficiently (Melo, 2023). This calls for instructors to overcome challenges to adopt AI tools in many science learning contexts so that they are stimulating and not incapacitating learning accomplishments. The teachers also thought about the matters of equity and accessibility while considering how to incorporate ChatGPT into science teaching.

As internet facilities become better, an issue that access to them is not equal for every student is on the rise. This view is supplemented by the school study concept "digital divide.". Chih-Yuan Sun and Metros, in 2011, also felt that merely because technology tools exist within education does not necessarily mean an individual's access or learning experience is equal. It can be supplemented by differing degrees in digital literacy, socio-economic splits, and inadequate infrastructure. ChatGPT can revolutionize science education, but its practical application needs to be considered while addressing such complexities of the problem to deal with a multicultural student population. The challenge of training teachers and integrating ChatGPT with current curricula is also posed as a concern. In an attempt to connect with Sampsa-Kanyinga et al. (2022)'s article, suggesting new technologies in education is always plagued by conformity and alignment issues with current education policy.

This is referring to the gravity of introducing an advanced tool and providing teachers with knowledge and skills sufficient to achieve maximum out of its functioning. To achieve effective integration of ChatGPT into current pedagogy, integrated training procedures and an overall support system in counseling and material must be established. The fifth issue that was triggered through discussion was the impact of ChatGPT on students' creativity. Creativity is a fundamental component of science learning as well as a fundamental component of overall development. The worry is that dependence on ChatGPT and AI software has the unforeseen result of undermining learners' ability to understand and articulate inotivally.

Students lose internal creativity when they overdepend on AI responses in learning science. On the basis of all the above points, the answer to the study problem is that there are several advantages to using ChatGPT in science education but it also has its disadvantages. To the third question of the study on future innovation in science education vs. technological developments, the views of the teacher expressed many useful findings. They are primarily interested in more holistic learning approaches. Teachers view platforms such as ChatGPT as an addition and not a substitute for normal class discussions. Outside what has been mentioned, the revolution is gradually shifting towards open school curriculums with an element of

technology. Teachers are advocating for curriculum changes to introduce tech-inclined learning strategies in conjunction with hands-on, experiential methods, with focus placed on the critical thinking element. The reforms are viewed as urgent to prepare the students for the networked, technology-facilitated world of today. Dienes.

This is aligning with the Learning Task whose emphasis is placed on making the learning real-world relevant to enable learning to become meaningful and pertinent (Baskara, 2023).

Other than this, the second significant trend is the demand for a better pedagogy. This is in line with the overall education trend towards building critical digital literacy in a high-speed data transmission era. With more advancements in AI affecting all aspects of life, there is a discussion among teachers of the growing relevance of skills such as exuberant intelligence, cultural communication, flexibility, and the ability to select the optimal mode of learning. All these abilities are now becoming increasingly essential with the rapid and changing world as it is, to supplement the 21st-century skills initiative that talks about how essential such skills are.

Typically, teachers anticipate an imminent future in years where science education combines the conventional with high technology, the middle ground, solution to instruction for students integrated. Care will be given to how to teach what is acquired in an environment that is relative to real life, creating more potential for analysis, and endowing students with diverse skills in an attempt to effectively utilize them in the age of artificial intelligence.

Implications

Results foresee a sequence of implications for educators, education program planners, legislatures, and education. Overhaul of the curriculum is inevitable. The potential of ChatGPTs to deliver learner-specific learning experiences demands a urgent need on the part of teachers as well as on curriculum planners to implement AI tools within their curriculum plans in a formal manner. It demands a new overhaul of the curriculum as a vehicle for restoring present content cosmetic overhauls. By opening the system so that technology can freely innovate, educators can make science education responsive and relevant to the needs of the new computer-age student. Staff development and media literacy are concerns no less urgent.

Special development programs are no-brainers if teachers are going to use ChatGPT in science education. These will not be teaching the technicality of ChatGPT, but university courses that will make use of the tool to its full extent. At the center is building classrooms where students can create suitable media literacy. The hope should be to produce students who will use AI development platforms meaningfully and sensibly. Other than this, with technology moving towards encompassing a whole branch of science education, student learning of social skills is now in the limelight. Cross-cultural communication skills, adaptability, and sensitivity to the social situation are becoming high tech classroom life heroes.

Besides that, with the fear of creativity suppression by use of technology tools like ChatGPT, the curriculum has to be coded for innovation in the sense of facilitating and empowering uses of technology by creativity-driven applications so that it can maximize it as an enabler and not a suppressor of creativity.

Equity and testing issues are also artificial intelligence in education's concerns. As more capability to learn with the aid of AI, there are ginormous questions related to access and equity issues. Education leaders and policymakers must press ahead to ensure that such technology won't contribute more to inequities in learning access.

And while computer program software can provide lots of types of feedback, we have to develop test plans more with the need for scientific accuracy than other concerns. Those need to be testing students' scientific literacy, experimental and analytical thinking capabilities. With those, we can achieve a framework by which the utilization of ChatGPT in scientific education is effective as well as Human-centered.

Limitations and recommendations for future studies

Although the research design of the present study is appropriate, there are some limitations which it has to be highlighted along with the recommendations for future studies. Those are local sites of participant sampling which can induce selection bias. Educators in the Zanjan province could possibly have differing

orientations to technology that would differ from the orientations of other educators in the entire country.

For the purposes of introducing greater diversity and varieties of pedagogical belief systems, participants must be recruited over a wider geographical range in future research.

While qualitative, open-ended questionnaires provide rich data, the lack of quantitative data does not put us in a position to be able to determine general trends. Best in future studies would be mixed-methods studies that would marry the richness of qualitative studies with the precision of quantitative studies. The second issue is biasness on the part of the trainers because they would have had some pre-exposure to ChatGPT. To maintain this variable in control, pilot copies of ChatGPT would be a wise thing to organize for utilization in future research such that input would be experienced personally. Since technology of AI is advancing at very rapid rates every day, results can become outdated in not-too-distant history. Hence, studies about the application and impacts of AI in the science lab should always be conducted to keep up with the times. Secondly, education in the form of seminars regarding AI should take priority by schools.

These workshops would familiarize instructors with the new skills and proficiencies of utilizing AI in education. Lastly, more studies of AI tools such as ChatGPT need to be conducted in order to answer the remaining research questions in this research. That is, in order for researchers to have a clear vision on how AI can affect education and how it can guide teaching and learning.

Conclusion

This study was conducted as exploratory research to study the attitudes of Zanjan province science teachers toward using AI tools, here ChatGPT, in the instruction of science. The general objective was to know what were the thoughts of the teachers regarding how the use of such technology is viewed within the context of their teaching practice. As much as the instructors thought that ChatGPT had the potential to facilitate more individualized education and immediate feedback, they were also concerned with overreliance and constraints. Some of the most pertinent concerns were the potential for stifling students' creativity, issues of accessibility, and sheer need for human contact in developing scientific thought and scientific inquiry. Usage of ChatGPT in science learning is of great worth and gigantic challenges but also ChatGPT can engage students more deeply, provide instant feedback, and customize learning according to individual requirements.

And whereas on the one hand, excessive reliance on AI, authenticity of information transmitted, and the unfeasibility of human direction being replaced by technology in education continue to be at the center of controversy. In order to have ChatGPT included in teaching meaningfully, there needs to be an equilibrium mechanism—a mechanism that harmonizes the traditional with new technologies. This positions AI in a support, and not replacing, role with respect to unreplaceable aspects of teaching and learning. For unlocking the best potential of technical advancements like ChatGPT, it is imperative to consolidate and safeguard the scientific foundations of teaching science. All technologies like ChatGPT are highly capable to transform science learning, but to utilize them appropriately requires a reflecting, inquiry-sustaining, and world-inclusive brain.

This kind of strategy will have to bridge the gaps in access, give top priority to teachers' professional development, and aim at developing critical thinking and creativity of students. This balanced strategy allows teachers to make AI an add-on to science teaching without sacrificing the foundation of science teaching. In plain language, the destiny of teaching science depends on achieving a stunning balance between making use of new technologies and maintaining the permanent demands of good pedagogy.

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