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Action Study

# Artificial Intelligence Helps Primary School Teachers to Plan and Execute Physics Classroom Experiments

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**Abstract**: The research claims that artificial intelligence technologies can help and direct primary school teachers in organising classroom experiments for physics instruction. Educators now have the potential to construct experimental projects that are entertaining and efficient, all while catering to their students' many learning styles and capabilities. This is made possible by the availability of artificial intelligence technologies. The incorporation of artificial intelligence into educational settings may result in an improvement in the overall quality of teaching as well as an improvement in the scientific performance of students. The chance to improve the learning experience for both students and teachers is available to educators who do an in-depth study on artificial intelligence-driven teaching solutions. The research highlights how artificial intelligence can transform teaching approaches in elementary school, notably in the field of physics education within the context of primary school settings.

**Keywords:** artificial intelligence; experiments; Physics teaching; primary school

## 1. Introduction

Artificial intelligence (AI) has become a powerful tool in education, providing several advantages to teachers and students (Luckin et al., 2016). AI is used in elementary school to help teachers create classroom exercises for disciplines such as physics. AI may assist educators in creating experiments tailored to the specific learning requirements of individual students. Furthermore, AI can provide immediate feedback during trials, enabling teachers to make rapid adjustments and enhancements. Implementing AI improves teaching and learning and promotes a more dynamic and engaging classroom setting (Pedro et al., 2019).

Direct experience in physics is essential for students to understand intricate ideas and theories (Holstermann et al., 2010). Students may enhance their comprehension of the rules of physics by participating in experiments and demonstrations. Engaging students in practical activities enables them to directly see the application of theoretical concepts in real-life situations, leading to improved understanding and memory recall of the subject matter (Schwichow et al., 2010). Furthermore, doing experiments enhances critical thinking abilities (Stephenson & Sadler-McKnight, 2016) and motivates students to tackle issues using scientific methods (Dandurand et al., 2008). Students engage in experiential learning, which enhances their comprehension of physics and fosters a better respect for the subject's complexities.

Teachers have a crucial role in developing classroom experiments for physics instruction. Their responsibilities include choosing appropriate experiments that match the curriculum's learning goals, making sure the required materials and equipment are accessible, and creating procedures that encourage student participation and interactive learning (Lavonen et al., 2004). Teachers must also consider safety precautions and provide precise directions to students to guarantee the successful execution of the experiment. Teachers may improve the quality of the learning experience and help students grasp complicated scientific topics by actively participating in the preparation process (Meltzer & Otero, 2014). The involvement of teachers in experiment preparation is essential for creating an excellent and successful learning environment in physics education.

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## 2. Applications of AI in Physics Education

Virtual simulations are becoming crucial in education, especially in scientific education (Rutten et al., 2012). Virtual simulations enable teachers to make complicated scientific topics more engaging and understandable for students via interactive and immersive learning experiences beyond the limitations of conventional teaching approaches. These simulations allow students to explore complex, if not impossible, recreated phenomena in a traditional classroom, improving their comprehension of basic scientific ideas. Virtual simulations may be customised to meet individual students' unique requirements and capabilities, offering a customised learning experience that can significantly enhance their educational results (Cant et al., 2022).

Customised learning experiences are gaining popularity in education because they address students' requirements and interests (Li & Wong, 2021). Using AI to support teachers in developing customised lesson plans and activities, students may participate in more significant and relevant learning opportunities (Shemshack & Spector, 2020). This customised method considers each student's learning styles, preferences, and talents, enhancing academic results. AI can help primary school teachers adjust their teaching techniques to meet the varied requirements of children, particularly in topics such as physics, where hands-on experiments are essential for grasping intricate ideas. Teachers may boost student engagement and understanding by creating a dynamic and engaging classroom environment via tailored learning experiences guided by AI (Fake & Dabbagh, 2023).

Analysis of data and providing feedback are essential in education, particularly for enhancing teaching methods and student achievements (de Carvalho et al., 2021). Teachers may get helpful insights into their students' learning and areas for growth by gathering and assessing data from classroom experiments. The data may include test results, student engagement levels, and instructor observations. AI systems provide teachers with immediate feedback on their teaching approaches, enabling them to make necessary changes. The dynamic method of data analysis may result in more efficient and captivating physics education experiences for teachers and students (Mobile Computing, 2023).

Primary school teachers may benefit from using various tools to efficiently plan classroom physics experiments with the help of AI. One suggestion is to investigate online platforms that provide interactive simulations and virtual laboratories tailored for instructional use (Hamed & Aljanazrah, 2020). These technologies provide teachers with a virtual platform to carry out and monitor experiments without actual apparatus. Academic books and magazines specialising in physics teaching techniques provide helpful insights and experimental concepts that may be adjusted for classroom application. Teachers may improve the quality of their physics experiments and include students in a more engaging and practical learning experience by using internet resources and instructional material (Shang et al., 2021).

## 3. Advantages of Artificial Intelligence Support for Teachers

Time economy is essential in teaching, particularly when planning classroom experiments for disciplines such as physics (Brown, 1992; Ahmad-Uzir, 2020). AI can help primary school teachers save time by automating tasks like experiment design, data gathering, and analysis. Teachers may concentrate on the intellectual parts of experiments and successfully interact with students during class time. By using AI to simplify these activities, teachers may guarantee that their classes are well-prepared and make the most of the limited time available in the classroom. (Darling-Hammond & Baratz-Snowden, 2007).

Improving the quality of experiments is essential for successful physics instruction in elementary school (Banda & Nzabahimana, 2021). Utilising AI to support and direct teachers in planning classroom experiments may significantly enhance the quality of these activities. AI may provide significant guidance in choosing suitable experiments that match the curriculum's educational goals, guaranteeing that students are actively involved and intellectually stimulated in their learning endeavours. Furthermore, AI may detect any drawbacks or areas needing improvement in the experimental arrangement, resulting in more precise data gathering and analysis. This improves the educational experience for teachers and students, leading to a more profound comprehension of physics subjects (Vlachos et al., 2024).

Enhanced student involvement is crucial in primary school settings as research indicates it results in improved academic performance and a more favourable learning environment (Bundick et al., 2014). Using AI to help teachers create stimulating classroom trials makes

students more likely to participate actively in the learning process (Pedler, 2020). Active engagement may enhance students' comprehension of intricate physics ideas and boost their academic success. Furthermore, AI can provide customised feedback to students according to their learning preferences, improving their interaction with the content. Implementing AI in the classroom may enhance learning by promoting higher student engagement and academic achievement (Kilbourne et al., 2023).

Professional development programmes are essential for educators to remain up-to-date and enhance their abilities (Karlberg & Bezzina, 2022). Primary school teachers may greatly benefit from seminars, conferences, and online courses that emphasise novel teaching methods, technology incorporation, and subject-specific expertise. These possibilities provide teachers with the necessary skills and resources to include their students in significant learning experiences, eventually resulting in improved academic achievements (Zepeda, 2019). Investing in professional development allows teachers to improve their classroom methods and provide a more dynamic and exciting educational setting for their students (Michael, 2022).

## 4. Challenges and Limitations of Artificial Intelligence Integration

Integrating AI support and guidance for physics teaching experiments may be a substantial financial obstacle for schools and educators due to initial deployment expenses (Kotsis, 2024). Obtaining essential technology, software, and training resources may be expensive, particularly for universities with restricted budgets (Kamat & Nasnodkar, 2019). Furthermore, one must consider continuous costs associated with software upgrades, technical support, and maintenance when calculating the expenditures of integrating AI technologies in the classroom. The long-term advantages of using AI technology in education, such as enhanced student engagement and learning results, may surpass the initial expenditure despite the hurdles. Educational institutions and decision-makers must thoroughly assess the advantages and disadvantages of incorporating AI into educational methods to guarantee that resources are effectively distributed to successfully integrate these advanced technologies (Costan et al., 2021).

Technical assistance and training are crucial for effectively integrating AI technologies into education. Primary school teachers using AI to plan physics experiments in the classroom need sufficient technical assistance to address any potential challenges that may arise throughout the process (Diana, 2021). Comprehensive training programmes are essential to provide teachers with the skills and expertise to incorporate AI into their teaching methods properly. Educators can optimise the potential of AI technologies to enhance students' learning experience and improve learning results by offering continuous technical assistance and training (Kandemir & Cicek, 2023).

Privacy and data security are crucial when using AI technology in educational environments. Teachers rely more on AI systems for classroom experiments; thus, it is crucial to consider the hazards of gathering and retaining sensitive student data (Ulven & Wangen, 2021). It is crucial to have data security measures and stringent privacy rules in place to preserve student confidentiality and maintain confidence in the school system (Josyula et al., 2023). Educators may confidently use AI's advantages by focusing on privacy and data security to safeguard student information integrity (Fabrègue & Bogoni, 2023).

An issue with using AI in elementary education is the risk of over-dependence on these technologies (Alam, 2021). AI can help teachers with physics experiments in the classroom, but there is a concern that educators might rely too much on these systems, which could result in a decline in students' critical thinking and problem-solving skills (Almulla & Al-Rahmi, 2023). Teachers need to balance using AI technologies for assistance and fostering students' creative and analytical thinking. Educators can optimise the advantages of AI technology and prevent excessive dependence by fostering a positive connection with these tools (Qadir, 2023).

## 5. Artificial Intelligence Tools for Experiment Planning

Practical experiment selection algorithms are essential for assisting primary school teachers in creating entertaining and informative physics experiments for their students (Yu, 2021). The algorithms consider learning goals, accessible resources, student demographics, and teaching styles to recommend experiments that align with the curriculum (Bruneau et al., 2023). Using AI technology, these algorithms can examine extensive data to suggest

experiments tailored to each class's unique requirements and interests. This customised method improves learning and promotes student involvement and analytical thinking abilities. Teachers may use these algorithms to save time choosing experiments and concentrate on providing top-notch education tailored to their students' requirements (Al-Gerafi, 2023).

Personalising education to accommodate various learning styles is crucial to providing all students equitable chances for achievement (Li & Wong, 2023). Students exhibit various information processing methods, necessitating teachers to cater to these variations. Teachers may effectively cater to students with diverse learning preferences by using a combination of instructional approaches, including visual aids, hands-on exercises, and aural explanations (Fariani, 2023). Adapting lesson plans to different learning styles boosts student engagement and fosters a more profound comprehension of the material. Personalised learning experiences may enhance student motivation and academic achievement. Adapting teaching tactics to cater to varied learners is crucial to effective education (Obidovna, 2023).

Integrating safety measures is crucial in classroom experiments in elementary education, especially in physics (Marougkas et al., 2023). By integrating safety protocols into experimental processes, educators can safeguard the welfare of students and reduce the likelihood of accidents or injuries (Savolainen, 2023). Integrating safety measures includes donning protective equipment, providing enough ventilation, and conducting studies in a controlled setting. Teachers may provide safety instructions to students before experiments and carefully oversee them throughout the procedure (Yu et al., 2023). Emphasising incorporating safety measures allows teachers to provide a safe and favourable learning environment for students to successfully investigate and interact with physics subjects (Sayfulloevna, 2023).

It is crucial to provide accessibility elements for various learners to establish an inclusive learning environment (Beyene et al., 2023). Educators may address the specific requirements of students with impairments, English language learners, and students from diverse cultural backgrounds by including these aspects (Page et al., 2023). Standard accessibility features include offering alternative formats for course materials like audio versions or braille translations, ensuring compatibility of electronic resources with screen reader software, and providing language support for non-native English speakers (Larios & Zetlin, 2023). By adopting these characteristics, educators may effectively include all students in the educational process and provide a fairer learning environment for all individuals in the class (Pizarro-Pedraza, 2024).

## 6. Collaboration Between Teachers and Artificial intelligence in Designing Experiments

Primary school teachers are crucial in providing advice and monitoring when using AI to help prepare classroom experiments for physics instruction (Kortemeyer, 2023). AI may provide helpful ideas and assistance using data and algorithms, but the instructor can customise these recommendations to suit their students' needs best. Teacher involvement ensures that experiments are conducted according to the curriculum, educational objectives, and students' learning styles. Teacher supervision is essential for assessing the experiments' efficacy and making necessary adjustments to improve the learning process. A more effective and exciting physics education technique may be built by integrating teachers' knowledge with AI technology (Sarsa et al., 2022).

AI recommendations and adjustments are essential for improving the efficiency of physics teaching experiments in the classroom. Primary school teachers may get personalised suggestions for adjusting experiments based on student performance data and learning preferences using AI algorithms (Chiu et al., 2023). These recommendations may assist teachers in customising their experiments to meet the requirements of individual students better, eventually enhancing the overall learning experience in the classroom. AI may help teachers discover areas for improvement in their experimental method and provide guidance to promote student knowledge and engagement (Ouyang, 2023). Utilising AI technologies in lesson planning may enhance physics teaching methods, resulting in increased efficiency and effectiveness, thereby aiding in student achievement and enhancing understanding of scientific principles (Burggräf et al., 2024).

Collaborative experiment iterations are essential for developing and improving classroom experiments for teaching physics (Narayanan et al., 2023). The educational experience may be enhanced via iterative procedures, including collaboration between teachers, students, and AI systems to test, assess, and improve trials. Educators may refine

trials to better match their students' learning requirements and styles by doing many rounds of experimentation, receiving feedback, and making improvements (Lesh & Kelly, 2012; Du et al., 2023). This iterative method boosts the quality of experiments and improves teaching and learning results in the classroom. Collaborative experiment iterations may promote a culture of ongoing improvement and innovation in physics education, as stated by Rietsche & Söllner (2019).

It is essential to balance automation and teacher innovation in elementary education to improve the quality of classroom experiments in physics instruction (Yu, 2024). AI may help teachers prepare experiments effectively, but it is crucial for educators to also include their creativity in the process. Teachers provide a distinct viewpoint and creative concepts that may enhance students' learning, promoting critical thinking and problem-solving abilities. Using AI solutions to automate administrative work and provide essential insights, teachers may allocate more time to creating stimulating experiments that accommodate various learning styles and abilities (Anderson & Taner, 2023). Integrating automation with teacher creativity has the potential to transform the way elementary classes approach and comprehend physics ideas.

## 7. Ethical Considerations in Implementing Artificial Intelligence

Detecting and reducing bias in algorithms is a critical component of integrating AI technology in education (Nazer et al., 2023). Bias identification entails scrutinising the data and algorithms for any underlying biases or discriminatory tendencies that might impact the results of the AI system (Austin et al., 2023). Mitigation measures include rectifying biases in the data, modifying the algorithms, and ensuring various views are considered throughout the design and implementation phases. Educators may enhance justice and equality in the classroom by directly confronting prejudice in AI technologies, creating a more inclusive and supportive learning atmosphere for all students.

Transparency in AI decision-making is crucial for accountability and justice in education. To trust and successfully use AI systems in the classroom, teachers need to comprehend how these systems arrive at their judgements (Choi et al., 2023). Teachers may understand the reasons behind AI systems' recommendations for physics experiments in the classroom by being open to decision-making (Chen et al., 2023). Educators may use this transparency to detect biases or faults in AI systems, enabling them to make essential improvements for accurate and fair decision-making. Transparency in AI decision-making is essential for building trust and enhancing the efficiency of AI systems in assisting teachers with their teaching methods (Ottenbreit-Leftwich et al., 2023).

Ensuring equity and inclusion in education is crucial for establishing a conducive learning environment that promotes the success and well-being of all students (Ferguson et al., 2018). We may strive for a more equitable society by guaranteeing all students equal educational opportunities regardless of their background or circumstances. Elementary school teachers must understand their children's varied needs and possess the necessary knowledge and instruments to provide practical assistance (Tohara, 2021). Educators may establish a classroom environment where all students feel valued and encouraged to learn by integrating ideas of equity and inclusion into their teaching techniques. By deliberately tackling structural obstacles to learning, such as poverty, inequality, and resource scarcity, we can progress towards a fairer and more impartial education system for everyone (Rodríguez-López, 2024).

It is essential to have ethical rules in place for the use of AI in schools to safeguard children's privacy and safety (Nguyen et al., 2023). When using AI technology in educational environments, it is crucial to consider aspects like openness, accountability, justice, and data security. Educators and school leaders need to be aware of the possible biases AI systems may adopt from the data they are trained on, which might adversely affect students from disadvantaged communities (Leaton-Gray, 2020). Clear procedures should be set for collecting and using students' personal information to avoid data misuse. Educators may use technology to include AI in classrooms while upholding ethical guidelines to protect their students' welfare (Divine et al., 2023).

## 8. Results and Discussion

AI technological advancements have transformed several areas, such as education. AI technologies have been created to help teachers in primary schools organise classroom activities in disciplines such as physics (Lee & Perret, 2022). AI systems may provide teachers

with recommendations for interactive experiments that match the curriculum, accommodate various learning preferences, and encourage practical learning opportunities for students. By using AI technology in this manner, educators may improve the quality of their teaching and provide a more engaging and influential scientific education experience for students. Integrating AI in primary education shows promise in enhancing student results and promoting a more profound comprehension of intricate disciplines such as physics (Hote, 2024).

Implementing AI in elementary schools to support teachers in designing classroom physics experiments will substantially affect education. Teachers may use AI technology to improve class preparation and delivery, resulting in more interactive and efficient student learning experiences. AI may customise education by adjusting to specific student requirements and learning styles, leading to better academic results and nurturing a lifetime passion for learning. AI's increasing sophistication is expected to broaden its involvement in education, potentially transforming future teaching and learning methods (Adiguzel et al., 2023).

Strategies for sustainable integration of AI in education include creating AI systems while prioritising ethical aspects, including privacy, fairness, and openness. Educators should work with AI specialists to customise AI systems to suit the unique requirements of the education industry. Continual training and professional development for teachers are crucial to enable them to incorporate AI into their teaching methods properly. Equipping teachers with essential assistance and resources to use AI technology may enhance student results and overall learning experiences.

Policy guidelines for integrating AI in education are essential to enable the efficient utilisation of technology to improve teaching and learning experiences. Clear standards on the ethical use of AI in education are necessary to tackle data privacy, prejudice, and responsibility issues. Develop training programmes to properly equip educators with the skills to employ AI technologies in their classrooms. Furthermore, it is essential to establish regulations that guarantee transparency, explainability, and accountability for AI systems used in education. Building trust among teachers, students, and parents is crucial for effectively integrating AI into education.

## 9. Conclusions

AI has provided several advantages to physics education, especially in designing classroom experiments. AI technologies enable teachers to access various materials and support to create and execute experiments that successfully illustrate intricate physical concepts. AI can provide immediate feedback, assess data, and recommend adjustments to experiments to improve student learning results. Through AI, educators may streamline experiment preparation, enhance data analysis precision, and boost the overall efficiency of physics instruction.

Reflecting on obstacles and ethical considerations is crucial when incorporating AI technology into primary education. AI may help teachers plan physics experiments for instruction, but it is essential to recognise the possible drawbacks and dangers of depending too much on automated methods. One problem is the ethical implications of using AI to substitute human teachers since it may depersonalise the learning experience. There is a worry about potential biases in AI algorithms that might result in unequal educational chances for kids from different backgrounds. Teachers must carefully analyse the influence of AI on teaching methods and aim to find a middle ground between technical progress and ethical concerns.

In primary school classrooms, achieving a balanced integration of AI requires emphasising ethical issues, providing teacher training, and conducting continuing assessments of AI systems. Educators must possess the expertise and abilities to successfully integrate AI technology into their teaching methods while maintaining the human aspect of education. Collaboration among educators, technology developers, and politicians is essential to guarantee that AI systems prioritise the well-being of kids. By using AI tools to complement and improve the teaching process instead of substituting human educators, we may achieve a more seamless incorporation of technology in the classroom that is advantageous for teachers and students.

The future of AI in education shows potential for improving the teaching and learning process, especially in areas such as physics. AI can help teachers create creative and captivating classroom experiments tailored to each student's requirements and learning preferences.

Educators may use AI technologies to provide customised learning experiences that encourage student interest and enhance critical thinking abilities. Teachers should use AI as a tool to improve human contact and teaching rather than to replace it. Educators must be diligent in ensuring that as AI advances and becomes more integrated into educational environments, it enhances learning rather than replacing it. The future of AI in education depends on how well teachers and schools use these technologies to assist student achievement and encourage continuous learning.

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