A COMPARATIVE ANALYSIS OF TRADITIONAL AND MODERN METHODOLOGIES FOR TEACHING AI AND ROBOTICS

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Abstract. The education sector has seen significant evolution in recent years with the inclusion of advanced fields like Artificial Intelligence (AI) and Robotics in school curricula. This paper aims to compare and contrast traditional and modern methodologies used for teaching these subjects, with a focus on the effectiveness, challenges, and outcomes for students. Traditional methodologies often involve lectures, textbooks, and theoretical knowledge dissemination, while modern approaches leverage hands-on learning, project-based learning, and interactive tools. The paper examines how these methodologies impact student engagement, learning outcomes, and the development of critical skills necessary for future careers in AI and Robotics.

Keywords—*Artificial Intelligence (AI), Robotics, project-based learning*

Introduction

As the demand for AI and robotics skills grows, it is crucial to equip students with the necessary knowledge and competencies to excel in these fields. Traditionally, education in subjects like robotics and AI relied heavily on lectures, demonstrations, and textbook-based learning. However, the rise of technology has brought about modern teaching methods that focus on interactive, hands-on learning and collaborative problem-solving.

This research aims to analyze and compare traditional and modern teaching methodologies for AI and Robotics education in schools, focusing on how these approaches influence the learning experience. The paper will explore various traditional methods, such as lectures and theoretical exercises, alongside contemporary techniques like project-based learning, gamification, and the use of digital tools and simulators.

Comparative analysis of the two approaches

– Traditional teaching methods, such as lectures, note-taking, and textbook exercises, have long been the cornerstone of education. These methods are teacher-centered, with the educator providing most of the information, while students passively receive the knowledge.

– In AI and Robotics education, traditional methods have primarily focused on theoretical understanding and rote memorization. For example, students learn algorithms, mathematical models, and theoretical concepts related to robotics and AI without practical implementation.

– Modern methodologies have shifted towards student-centered learning. Techniques such as project-based learning (PBL), inquiry-based learning (IBL), and flipped classrooms are increasingly being adopted in AI and Robotics education [1].

– These methods encourage students to take a more active role in their learning process. PBL, for example, requires students to solve real-world problems through hands-on projects, enhancing their problem-solving and collaborative skills.

– The use of digital tools, simulators, and coding platforms (e.g., Arduino, Raspberry Pi, and simulation software) has significantly changed how AI and Robotics are taught in schools.

Traditional methods are often more structured and easier to implement but tend to lack engagement and fail to foster critical thinking. Modern methods, while more resource-intensive, have been shown to enhance student engagement, creativity, and practical skills.

Modern methodologies have been proven to increase student interest and active participation, while traditional methods often fail to capture the students' attention beyond passive listening.

In modern methodologies, students develop a wide range of skills such as critical thinking, teamwork, and creativity. Traditional methods, while effective for building foundational knowledge, often do not provide opportunities for students to apply what they have learned in real-world scenarios [2].

Methodology

This research utilizes a comparative approach, analyzing both qualitative and quantitative data on the effectiveness of traditional and modern teaching methods. The following methods will be used:

- A survey was conducted among 735 students, 542 parents, 33 ICT teachers, and 12 school principals in Tashkent to assess the current state of AI education and to gauge their perspectives on the effectiveness of traditional versus modern methodologies [3].
- Teachers were interviewed to gather qualitative insights into the challenges and opportunities associated with teaching AI and software programming in schools.

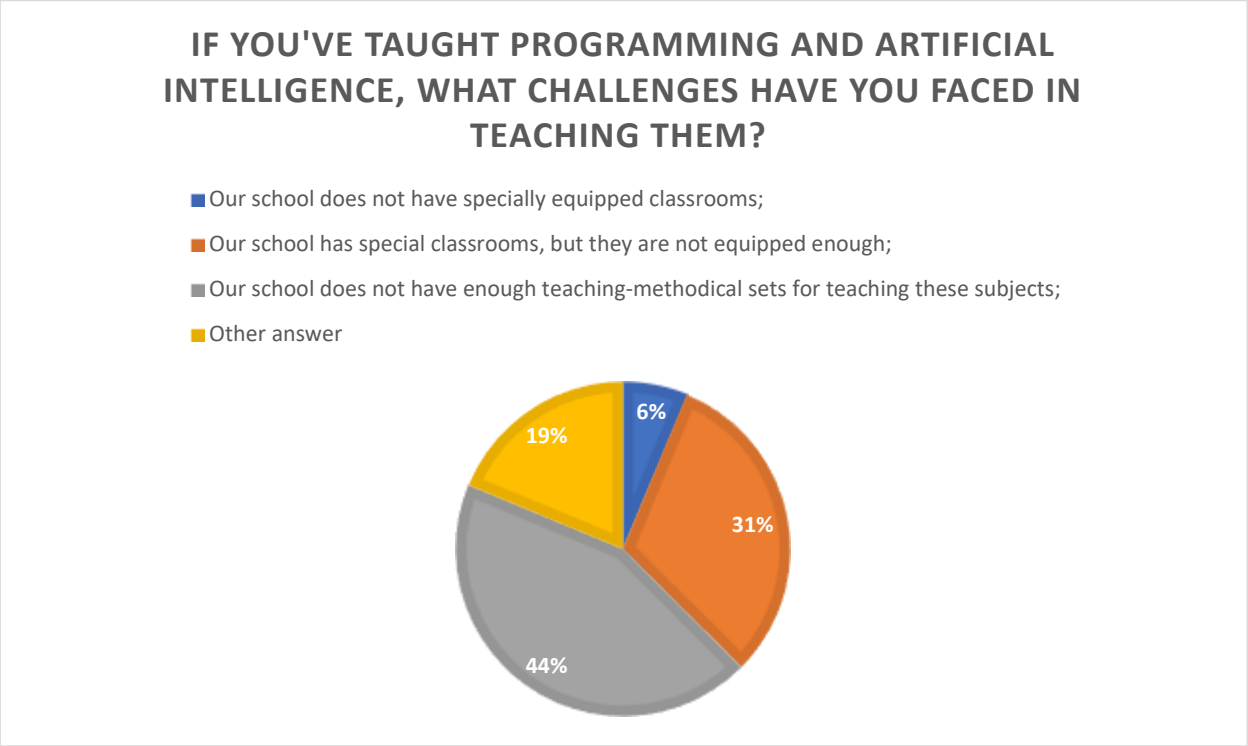

Fig 1. Existing challenges for running appropriate training.

The (Fig 1.) measures the challenges teachers are facing to run an appropriate class on AI&SW topics. As the observation shows, many teachers say there are not enough methodical sets for teaching these topics. 31% of teachers report that schools are designed with special classrooms but don't have equipment related to demonstration these technologies like, IoT, robotics, tools for establishing VR.

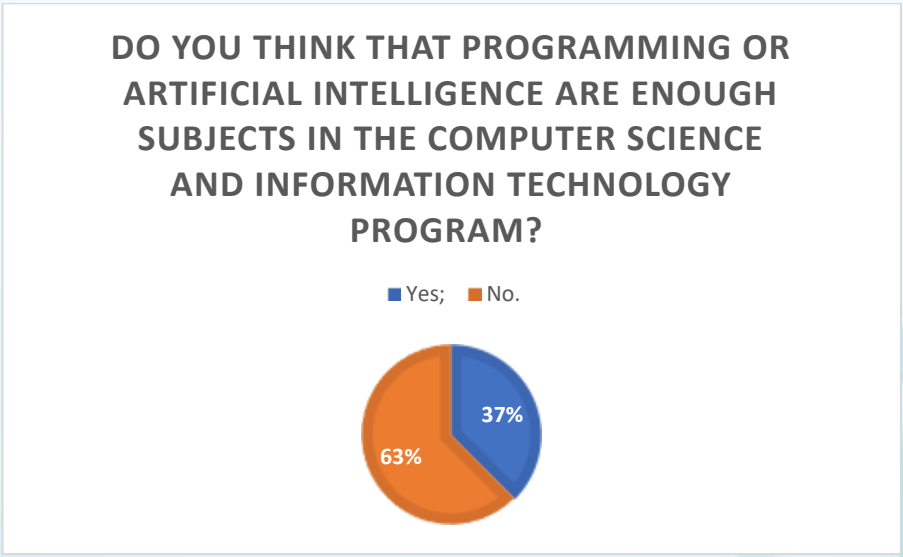

Fig 2. Syllabus analyses

As the introduction part of the proposal reports, the country is reforming its educational system and opening opportunities for innovative approaches to teaching

and learning. Figure 2 shows many schools already adopted AI and SW topics in their Informatics syllabus.

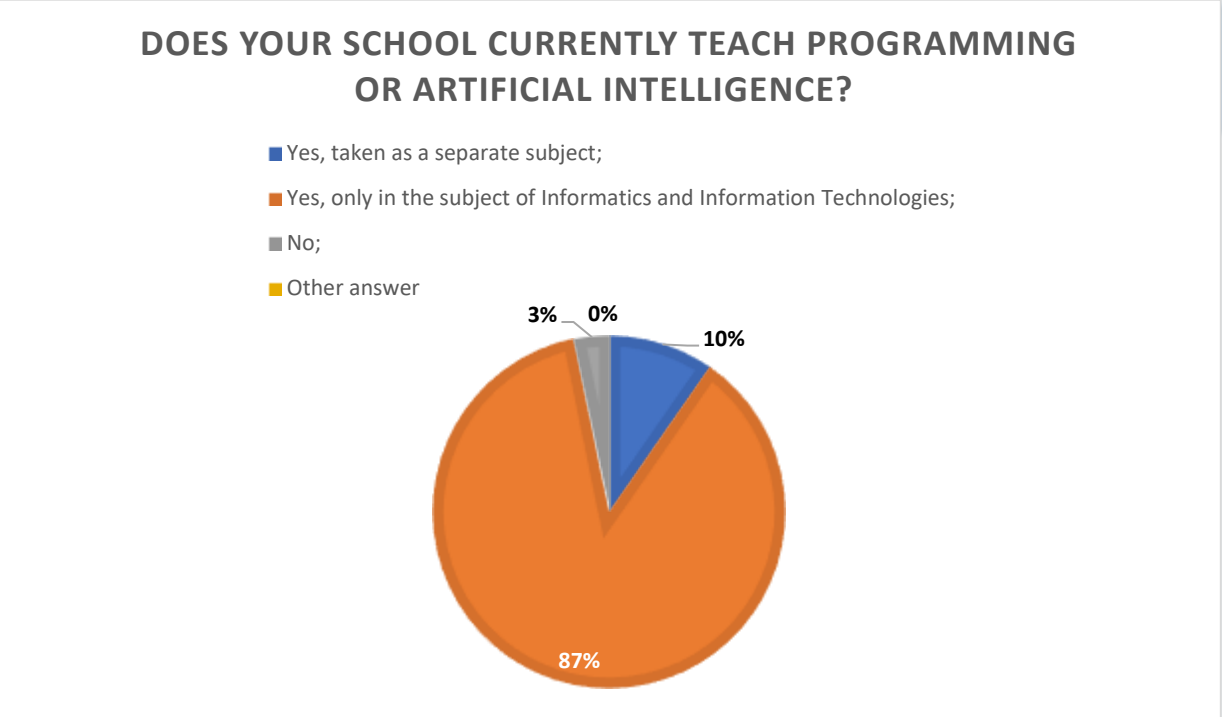

Fig. 3. Teacher perceptions on availability of AI and SW in school curriculum.

The pie chart on (Fig. 3.) illustrates the distribution of opinions across various schools. A significant number of teachers report on the inclusion of AI and SW in the subject curriculum. These numbers inversely correlate with student answers on (Fig.4). Whereas schools include AI and SW in syllabus, there is a lack of student knowledge (Fig. 4, 51%). This indicates a major demand for methodical support for teacher training and for software/hardware support.

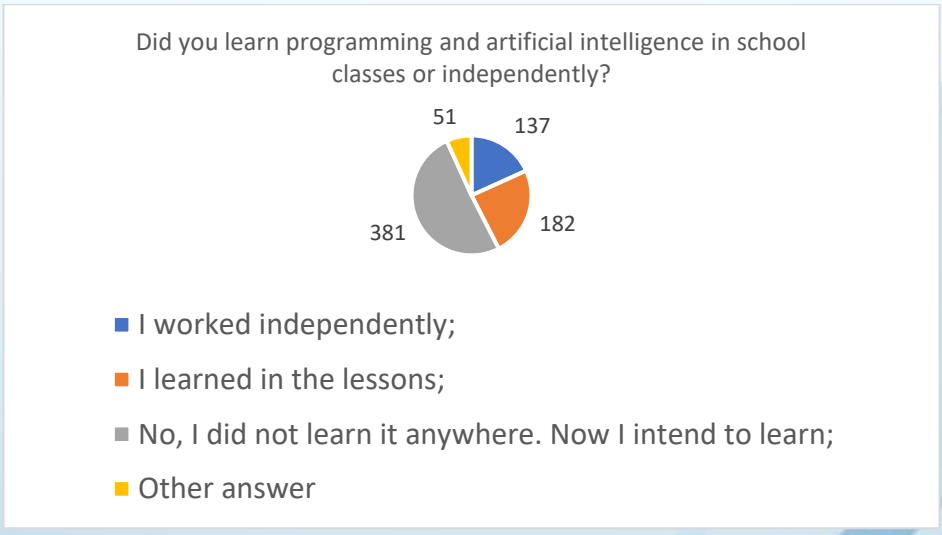

Fig 4. Student answers.

Collectively all teachers report their positive belief for the support.

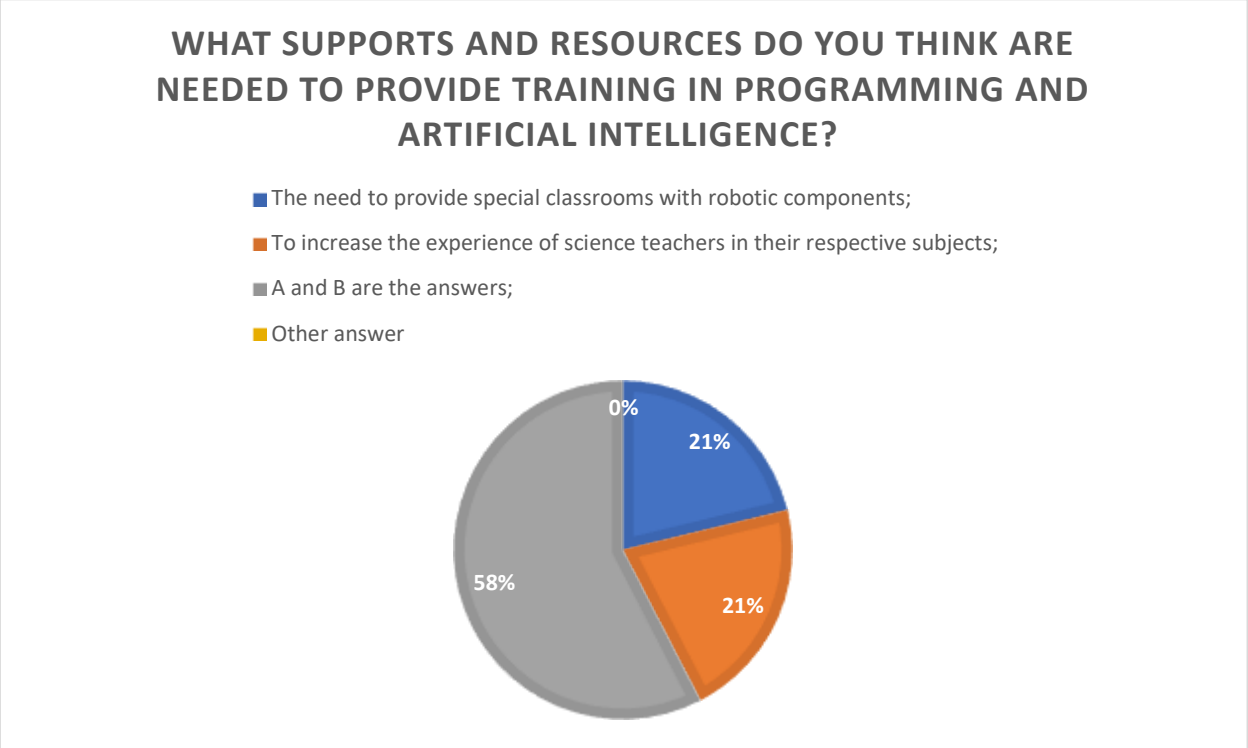

Fig 5. Measure for training needs

As Figure 5 above illustrates teachers seek help on getting professional development in AI & SW topics. However, their needs are divided into two, 21% need technical equipment, another 21% need methodical and training needs. At the same time, another 58% of teachers think there is a need for both.

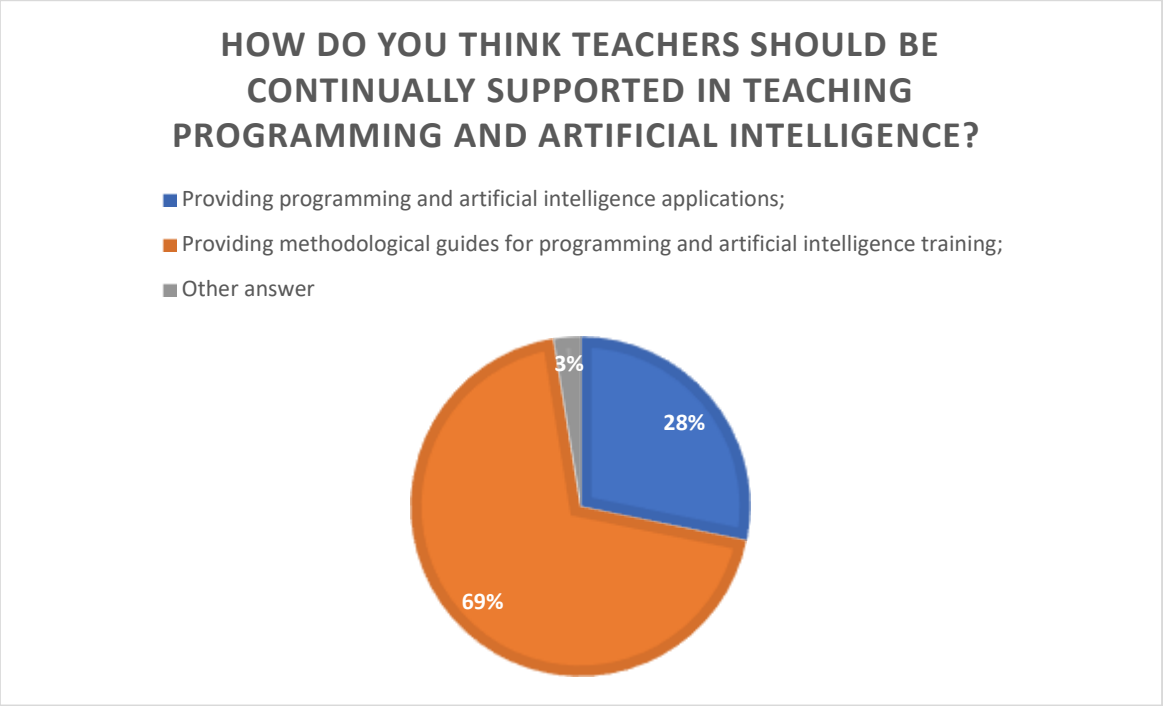

Fig 6. Continuous professional development

The prospects for the majority of teachers in programming and AI education is in Computer Science and Information Technology 87% (Table 4). AI is a rare topic which teachers cover in their computer science subjects for higher grade classes. Very few teachers, 23% have expressed that they have teaching experience in AI. But 56% of teachers have proficiency in teaching software programming. These teachers usually had programming topics such as algorithms, functions, databases, web programming (23/32). Notable attention should be taken to the needs for support such highlights are presented below: lack of equipped classrooms (12/32) and educational and methodological collections are not enough (14/32).

When we asked if they need an adequate training plan related to programming or AI, more than 100% of them showed willingness and necessity.

Teachers reported that resources are needed for training in programming and artificial intelligence, these are some highlights from observations from the data: special classes with robotics components (7/33); - advanced training for ICT teachers (7/33) and combination of the two – equipping special classrooms and teacher trainings (19/33). 100% of Tachers showed there is a need for professional development.

The data reflects a diverse landscape among teachers teaching programming and artificial intelligence. While acknowledging the positive predisposition to these disciplines and their importance, challenges in resources, classroom infrastructure and professional development opportunities are evident.

Teachers are very interested in programming and the inclusion of AI in education. However, there is a clear need for expanded resources, improved infrastructure and personalized professional development to support effective training in these areas.

Different responses highlight the need for comprehensive strategies that address resource shortages and professional development opportunities to facilitate effective training of programming and artificial intelligence across different classes and disciplines.

Results and discussion

– Students in classrooms that adopted project-based learning and other modern methodologies were more engaged and motivated to learn. They showed higher levels of participation in discussions and problem-solving activities.
– In contrast, classrooms using traditional methods often experienced lower engagement, with students demonstrating minimal participation outside of direct instruction.
– Modern methodologies led to better understanding and retention of concepts. Students in project-based learning environments were able to apply theoretical knowledge to real-world problems and develop practical skills.
– Traditional methodologies, while effective in delivering foundational knowledge, did not allow students to see the practical applications of what they were learning.
– Teachers noted that modern methodologies, especially PBL, required more preparation and resources but resulted in more satisfied students and better overall outcomes.
– Traditional methods, while easier to manage, were often criticized for being outdated and less effective in preparing students for the demands of the digital economy.

Conclusion

The comparative analysis of traditional and modern methodologies for teaching AI and Robotics reveals that while traditional methods are still useful for delivering foundational knowledge, modern methodologies offer a more engaging and effective way to develop the skills needed for success in the rapidly evolving fields of AI and Robotics. Modern approaches like project-based learning, inquiry-based learning, and the use of digital tools not only improve student engagement but also help students develop critical skills such as problem-solving, collaboration, and

creativity. It is recommended that schools adopt a hybrid approach that integrates both traditional and modern methodologies to ensure a balanced and comprehensive education in AI and Robotics.

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