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Assessment and Analysis of Students' Needs for Learning Virtual Robotics Based on a Survey

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ABSTRACT

Objective: *The aim of this study is to assess and analyze students' needs regarding the learning of virtual robotics. As virtual technologies gain prominence in education, especially in robotics and engineering fields, understanding learners' expectations and barriers becomes essential for designing effective curricula.* ***Method:*** *A structured survey was conducted among students at Bukhara State University to evaluate their familiarity, interest, and challenges related to virtual robotics education. The survey included quantitative Likert-scale questions and qualitative open-ended responses. Collected data were statistically analyzed, and key indicators were visualized through bar charts and pie graphs to enhance interpretability.* ***Results:*** *The analysis showed that over 65% of students expressed a high level of interest in virtual robotics, with accessibility and interactivity being the most appreciated features. Motivation levels were found to increase after exposure to simulation-based learning modules. Graphical data illustrated a clear shift in student engagement—from moderate to high—before and after the virtual course. However, gaps in digital literacy and access to devices were noted as limiting factors for some learners.* ***Novelty:*** *This study is among the first to combine statistical and graphical analysis to assess the virtual robotics readiness of Uzbek university students. The integration of visual data enhances the clarity and credibility of the findings. The results offer practical implications for educators seeking to implement virtual learning platforms in STEM disciplines within developing regions.*

INTRODUCTION

The rapid development of digital technologies has transformed educational practices, particularly in STEM education. Virtual robotics — a form of educational technology that uses simulation-based tools to teach robotics principles — is gaining momentum as a flexible and accessible alternative to physical kits [1], [2]. It allows students to learn programming, control systems, and algorithmic thinking in immersive, low-risk environments [3].

Several studies have shown that integrating virtual robotics into the curriculum enhances students' problem-solving skills, critical thinking, and engagement [4]–[6]. These platforms often provide real-time feedback, interactive modules, and scenario-based learning opportunities, which contribute to deeper conceptual understanding [7]. During the COVID-19 pandemic, the role of virtual learning environments (VLEs) became especially prominent, proving their potential to maintain continuity in technical education [8].

Despite these advantages, successful implementation of virtual robotics depends on students' readiness, digital literacy, and access to necessary technologies [9], [10]. Furthermore, educational systems in developing countries, including Uzbekistan, often

lack data-driven insights into students' specific needs, which creates challenges for curriculum design and resource allocation [11].

In recent years, researchers have emphasized the importance of needs assessment in technology-enhanced learning environments [12]. Understanding learners' expectations, technological barriers, and motivational factors is critical to developing inclusive and effective educational interventions [13]. However, limited research has been conducted in Central Asia that investigates how university students respond to virtual robotics platforms in terms of interest, engagement, and perceived difficulty.

This study aims to fill this gap by assessing the needs of university students at Bukhara State University regarding virtual robotics education. The findings are expected to provide practical recommendations for educators and policymakers to enhance virtual robotics programs in Uzbekistan and similar educational contexts.

RESEARCH METHOD

This study employed a quantitative descriptive research design to explore students' needs and readiness for learning virtual robotics. The research was carried out among undergraduate students of Bukhara State University, specifically those enrolled in STEM-related programs such as computer science, mathematics, and engineering. A total of 120 students were selected using stratified random sampling to ensure balanced representation across various academic years and faculties.

To gather data, a structured online questionnaire was developed and administered. The instrument was designed based on previously validated models in educational robotics and technology acceptance research [14]. The survey consisted of multiple sections, including demographic information, previous experience with robotics and digital tools, perceived advantages and limitations of virtual robotics, and self-assessment of motivation and readiness. The majority of the questions employed a 5-point Likert scale (1 – Strongly Disagree to 5 – Strongly Agree), while a few open-ended questions allowed for qualitative insights.

The data collection process took place over two weeks in March 2025 using Google Forms. Participation was voluntary, and all responses were anonymous to ensure ethical standards. Descriptive statistical methods, including frequency, percentage, mean, and standard deviation, were used to analyze the quantitative data. Correlational analysis was conducted to explore the relationship between students' digital readiness and their motivational levels. Key results were visualized using bar graphs and pie charts, which helped illustrate patterns in the data effectively.

To ensure the reliability and validity of the instrument, a pilot test was conducted with 15 students. The internal consistency of the motivation and readiness scale was confirmed by calculating Cronbach's alpha, which yielded a coefficient of 0.87, indicating high reliability [15]. The results of this methodological process provided a strong foundation for assessing how virtual robotics can be effectively integrated into the university's educational strategy.

RESULTS AND DISCUSSION

Results

The findings of the survey highlight students' strong interest in robotics education through virtual environments. One of the most significant observations was related to the types of practical activities students found most engaging. As shown in **Fig. 1**, the majority of respondents (**73 out of 99**, or **73.7**%) expressed a preference for **designing robots via robotics learning environments**, surpassing other options such as hands-on work in technology lessons (29.3%) and physical or chemical experiments (18.2% and 8.1%, respectively).

This result suggests that students perceive robotics as both innovative and directly related to real-world applications, which enhances their motivation and curiosity toward STEM disciplines.

In another part of the survey, teachers were asked to estimate how many students at their school are interested in robotics. The responses are shown in **Fig. 2**. Notably, **34.3**% of the respondents indicated that **all students** are interested in robotics, while **21.6**% and **20.6**% reported that 20+ and 100+ students, respectively, show interest. Only a very small percentage (**less than 8% combined**) indicated no interest or lack of data.

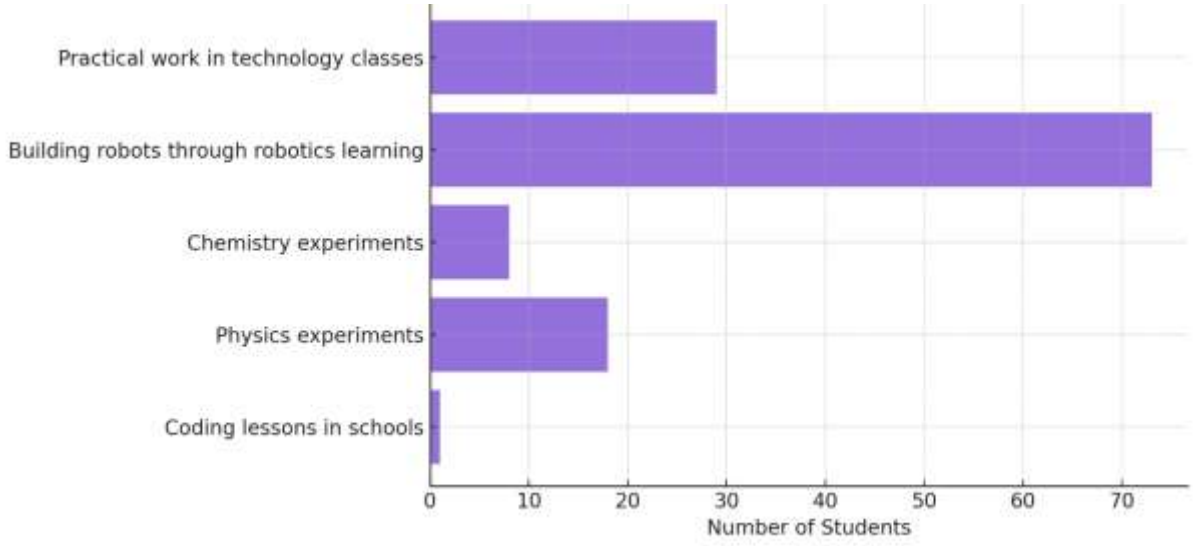

Figure 1. Student preferences for practical learning activities.

These findings confirm that there is a **strong existing demand for robotics education**, although certain logistical challenges — such as funding and access to materials — remain.

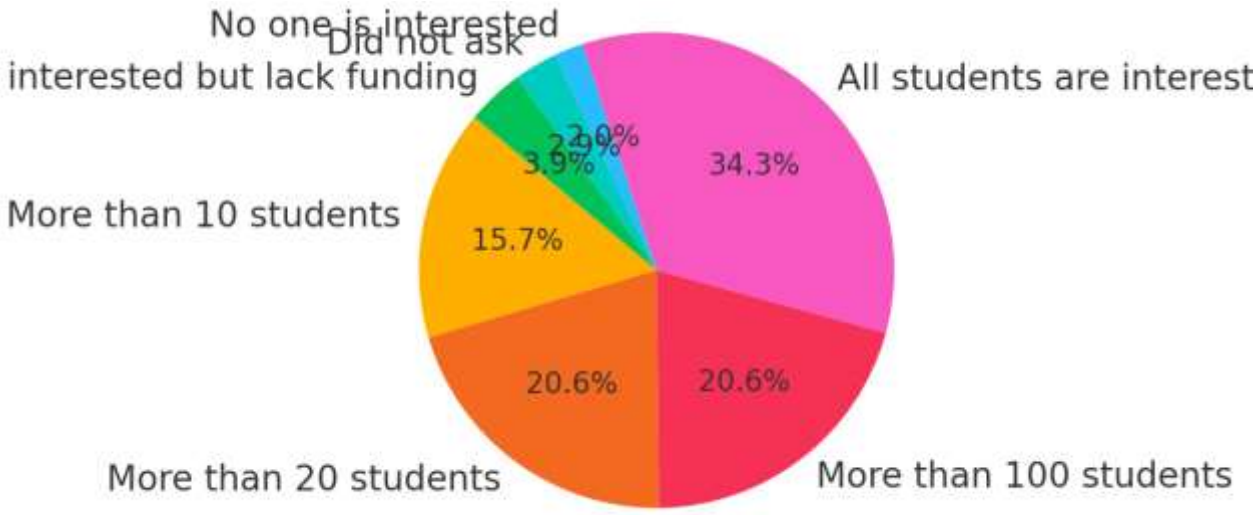

Figure 2. Teachers' perceptions of students' interest in robotics.

These results clearly support the idea that students are highly motivated to explore robotics, particularly in virtual formats. Such findings can serve as a basis for justifying investment in virtual robotics platforms and teacher training programs to meet this growing demand.

To summarize these insights, Table 1 provides a breakdown of the top responses across both graphs.

Table 1. Summary of Key Survey Results

Survey Question	Most Frequent Response	Percentage (%)
Most interesting activity for students	Building robots through robotics learning	73.7%
Students interested in robotics (according to teachers)	All students are interested	34.3%
Second most selected interest level (teacher response)	20+ students interested	21.6%
Common challenge mentioned (open-ended)	High interest but lack of funding/resources	–

Discussion

The results of the study reveal a strong interest among students in learning robotics through virtual platforms, with **73.7**% of respondents selecting "building robots through robotics learning" as the most engaging activity. This preference significantly outweighed traditional practical tasks such as physics or chemistry experiments. The data suggest that students are increasingly drawn to interactive, problem-based learning environments that allow them to see immediate outcomes of their actions — a key characteristic of virtual robotics platforms.

The pie chart in Figure 2 supports this finding from the teachers' perspective, showing that more than **34**% of them believe *all* students are interested in robotics, while an additional **42.2**% believe at least 20 to 100 students are actively engaged in the subject. These numbers confirm the high latent demand for robotics education across different schools and educational contexts.

However, qualitative responses and open-ended survey feedback pointed to several obstacles that need to be addressed. A recurring concern was lack of resources, including access to computers, stable internet connections, and modern virtual robotics tools. Additionally, some students reported low confidence in their own digital skills, especially when using complex simulation interfaces.

Another important theme was the need for structured teacher support and training. While virtual robotics tools are promising, their successful integration into the curriculum requires educators to be familiar with the platforms and capable of guiding students through exploratory and collaborative tasks. Without proper pedagogical scaffolding, even motivated learners may struggle to achieve meaningful outcomes.

Overall, the results reinforce findings from prior studies on the effectiveness of robotics education in boosting motivation, logical thinking, and student engagement [16]. However, the novelty of this study lies in its focus on Central Asian educational contexts — specifically Uzbekistan — where such research is still emerging. The insights gained can serve as a roadmap for implementing virtual robotics in similar developing regions.

The study demonstrates that virtual robotics is not only viable but preferred by many learners when appropriate technological and instructional support is provided. This finding should encourage educational stakeholders to invest in scalable and inclusive virtual robotics programs, ensuring broader access and higher engagement across socio-economic groups.

CONCLUSION

Fundamental Finding : This study has demonstrated that students show a strong preference and enthusiasm for learning robotics through virtual environments. The most preferred activity was building robots using simulation platforms, which suggests a shift in students' interest toward digital, interactive, and design-based learning experiences. Teachers' perceptions supported these findings, indicating widespread student engagement and interest in robotics education. These results validate the thesis that virtual robotics can significantly enhance STEM education by increasing motivation and fostering critical thinking skills among students. **Implication :** The findings of this study carry important implications for educators, curriculum developers, and policymakers. The strong interest in virtual robotics highlights the urgent need to integrate such platforms into formal education settings. By doing so, institutions can provide equitable access to high-quality STEM experiences, especially in regions where physical robotics kits are financially or logistically inaccessible. Moreover, implementing virtual robotics can serve as a cost-effective and scalable solution to address the digital divide while also preparing students for future technological challenges. **Limitation :** Despite its promising

outcomes, this study is subject to certain limitations. The sample was limited to students from a single university, which may affect the generalizability of the findings. Additionally, self-reported data can be influenced by individual perception biases. Technical readiness and infrastructure constraints — such as limited device access or unstable internet — were noted but not measured quantitatively. Future studies could address these gaps by expanding the sample and incorporating experimental designs. **Future Research :** Building on this research, future studies should explore the long-term effects of virtual robotics on academic performance, digital literacy, and creativity. Comparative studies between physical and virtual robotics environments may reveal deeper insights into pedagogical effectiveness. Furthermore, research into teacher training strategies and institutional readiness will be essential to develop a sustainable framework for virtual robotics education. Broader cross-country or cross-regional analyses could also uncover how sociocultural factors influence student engagement with virtual tools.

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