THE NECESSITY OF ESTABLISHING A STEM PARK: IMPACT ON STUDENTS’ ABILITY TO PERFORM EFFECTIVELY IN A RAPIDLY CHANGING ENVIRONMENT

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ABSTRACT

In the modern education system, it is not enough for students to acquire only academic knowledge; developing their social and emotional competencies is also of great importance. Emotional intelligence and adaptability are key prerequisites for successful socialization, readiness for lifelong learning, and effective action in a rapidly changing environment. The creation of a STEM park makes it possible to form an adaptive educational environment, which, through technology-based and project-based experiences, provides conditions for developing these competencies. In such an environment, students learn to regulate their emotions, adapt to new situations, think creatively, and work effectively in teams. The purpose of this study is to identify ways of developing students’ emotional intelligence and adaptability through STEM technologies and to highlight the need for integrating the STEM park into the educational process. Methodologically, literature review, theoretical analysis, project-based and experimental methods, observation, expert analysis, and visualization techniques were applied. Projects and experiments carried out with STEM tools (Arduino, 3D printing, robotics) demonstrated high effectiveness in enhancing students’ emotional intelligence and adaptability, clearly revealing the necessity of establishing a STEM park. As prerequisites for creating a STEM park, an organized educational environment was found to not only deepen students’ academic knowledge but also contribute to the comprehensive development of their personal and social competencies.

Keywords: STEM park, emotional intelligence, adaptability, STEM technologies, adaptive educational environment.

INTRODUCTION

In the 21st century, the education system is undergoing fundamental changes. Globalization, digital transformation, and the rapid development of the labor market require students to acquire not only subject-specific knowledge but also universal, flexible, and adaptive skills. Among these, emotional intelligence and adaptability stand out as some of the most important competencies of modern times. They serve

as guarantees of students' successful socialization, adaptation to changing environments, and readiness for lifelong learning.

The development of emotional intelligence and adaptability has become a pressing subject of study within the global pedagogical community. The UN, UNESCO, and other international organizations consider 21st Century Skills as one of the key priorities of education systems and are identifying effective ways to integrate them into the learning process. The formation of these competencies should not be limited to academic education alone but must also be based on theoretical and methodological foundations that support students' social, personal, and emotional development.

In this regard, designing an adaptive educational environment based on STEM technologies plays a crucial role in developing students' emotional intelligence and adaptability. Such an environment enables students not only to enhance their abilities in recognizing and managing emotions, teamwork, and creative activity but also to improve their capacity to absorb new knowledge, make decisions in complex situations, and adapt to change.

Problem-based learning methods also hold significant importance in STEM education. Research by Martinez and colleagues demonstrated that group tasks strengthen leadership, communication, and analytical thinking skills [1]. These methodologies also help account for structural differences in transitional potential, taking into consideration the diverse regional conditions and socio-economic development characteristics of Kazakhstan [2].

This study, in particular, investigates effective ways of developing emotional intelligence and adaptability in the educational process through the use of STEM technologies, thereby strengthening students' functional and social competencies [3]. The integrative model proposed in this work introduces a new perspective into the education system, laying the foundation for students' mastery of 21st-century skills and their future professional success. Such comprehensive development enhances not only students' technical knowledge but also their emotional resilience and social adaptability.

These methodologies can also be applied to graphematic analysis of Kazakh-language texts [4] and to the evaluation of the European Union's new strategy for the Central Asian region, taking into account regional geopolitical contexts [5]. Furthermore, the findings of this study allow for the exploration of cultural differences in Kazakh and English-language business communication and the development of effective cross-cultural communication strategies [6].

Strategies for developing students' emotional intelligence and adaptability within STEM education are widely discussed in international research. For example, Salman and colleagues show that the use of cooperative learning methods in STEM subjects plays a key role in fostering students' collaboration, communication, and leadership skills [7].

In their study on adaptability, Lee and Kim [8] emphasize the impact of national and social contexts on students' adaptive abilities. Rahman, in his research on constructivist methods, demonstrated through STEM projects the effectiveness of such approaches in enhancing students' critical thinking and social adaptability [9].

Following the COVID-19 pandemic, demand for emotional intelligence and adaptability has increased significantly. Konzello and his research team highlighted

the importance of soft skills such as negotiation and active listening in the labor market [10].

Currently, various methodologies are aimed at developing students' emotional intelligence and adaptability. However, their theoretical foundations remain unsystematized and insufficiently analyzed in the context of STEM education. This reduces the effectiveness of teaching and creates difficulties in making methodological decisions. Therefore, designing an adaptive educational environment based on STEM technologies to enhance students' emotional intelligence and adaptability is a scientifically relevant issue.

RESEARCH METHODOLOGY

This study examined an adaptive educational environment based on STEM technologies that fosters the development of students' emotional intelligence and adaptability. A set of methods was applied in a comprehensive manner:

- Literature review and theoretical analysis. The theoretical foundations of the concepts of emotional intelligence and adaptability were examined, and a comparative analysis was conducted from the perspectives of constructivism, humanistic pedagogy, and social-cognitive theory.
- Project-based and experimental methods. Students completed projects using STEM tools (Arduino, 3D printing, robotic kits, mechanical models) and solved experimental tasks.
- Observation and expert analysis. During project and group work, students' emotion regulation, adaptation to new situations, and collaboration were directly observed and subjected to descriptive analysis.
- Qualitative research methods. Case examples describing students' creative, communicative, and research activities were collected.
- Visualization methods. Models created with 3D printing, Arduino-based prototypes, and STEM kits were used in the teaching process, and their effectiveness was comparatively evaluated.

By combining these methods, the impact of STEM technologies on the development of students' emotional intelligence and adaptability was comprehensively identified.

RESEARCH FINDINGS

Emotional intelligence and adaptability are among the key competencies that ensure the holistic development of students' personalities in the modern education system. Emotional intelligence is the ability to understand and manage one's own emotions, show empathy towards the emotions of others, and establish effective communication. Adaptability, in turn, refers to a student's capacity to quickly adjust to changing conditions, acquire new knowledge, and solve unexpected challenges in a creative way. These two competencies form the core of 21st-century skills and gain unique opportunities for development within an educational environment organized on the basis of STEM technologies.

Figure 1. Experimental models and teaching tools developed on the basis of STEM technologies

In this study, teaching tools and experimental models developed on the basis of STEM technologies were utilized. Figure 1 illustrates models created through 3D printing, projects based on the Arduino platform, robotic kits, and mechanical devices. For example, a device designed to automatically solve a Rubik's cube, models with mechanical movement, and scientific-educational prototypes produced by 3D printing were applied in the learning process. These tools were aimed not only at reinforcing students' subject knowledge but also at developing their creative abilities, emotional intelligence, and adaptability to new situations. During project-based and experimental activities, students learned to collaborate in groups, express their ideas openly, and provide mutual support to one another.

Figure 2. Students presenting their projects developed on the basis of STEM technologies

The use of STEM technologies had a clear impact not only on the development of students' emotional intelligence and adaptability but also on their cognitive and social abilities. In particular, during practical and project-based tasks, students learned to regulate their emotions, speak confidently in public, support one another within groups, and demonstrate empathy. Solving technical challenges encountered in new situations enhanced their adaptability and strengthened their flexible thinking skills. Moreover, activities carried out with STEM tools created opportunities for students to think critically, present new ideas creatively, and apply analysis and synthesis. Group and project work further developed their communication, collaboration, and leadership skills. Such experiences not only enriched students'

academic knowledge but also strengthened their personal and social potential, while reinforcing their ability to adapt to a changing environment. Overall, an adaptive educational environment organized on the basis of STEM technologies contributed to preparing students in line with the demands of the 21st century, enabling them to develop the competencies that form the foundation for their professional and personal success.

Table 1. Skills Developed Through the Use of STEM Technologies

Direction	Developed Skills	Example
Emotional intelligence	-Emotion regulation -Empathy - elf-control	During group project presentations, students spoke confidently and supported each other.
Adaptability	- Quick adjustment to new situations - Flexible thinking - Problem-solving	When errors occurred in Arduino or robotics tasks, students proposed alternative solutions.
Cognitive abilities	- Critical thinking - Creativity - Analysis and synthesis	While creating 3D-printed models, students generated new ideas.
Social abilities	- Communication - Collaboration - Leadership	In project work, each student took on a role and worked collaboratively.

Thus, the findings of the study demonstrated that an adaptive educational environment created through the use of STEM technologies provides opportunities for the comprehensive development of students' emotional intelligence and adaptability. In such an environment, students simultaneously enhance their skills in emotion regulation, adaptation to new situations, creative thinking, and collaborative action, thereby establishing a solid foundation for mastering 21st-century skills and ensuring future professional success.

CONCLUSION

The results of the study confirmed that an adaptive educational environment organized on the basis of STEM technologies plays a significant role in developing students' emotional intelligence and adaptability. During practical and project-based tasks, learners acquired skills in managing their emotions, showing empathy, and working in teams; they were also able to think creatively in new situations and find alternative solutions to problems. The use of STEM tools enhanced their cognitive activity, while also improving their critical thinking, communication, and leadership abilities.

In addition, it was revealed that the application of STEM technologies provides opportunities not only for academic achievement but also for the comprehensive development of students' personal, social, and professional competencies. Such an approach prepares learners in line with the requirements of the 21st century and establishes a solid foundation for their future professional and personal success.

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REFERENCES

1. Martínez-Ávila, J., Cortés, R., & Torres, D. (2020). Problem-based learning for bioengineering students: Soft skills development through teamwork. International Journal of Educational Methodology, 6(3), 411–425. https://doi.org/10.12973/ijem.6.3.411
2. Kaliyeva, G., Bekturganova, Z., & Zhidebekkyzy, A. (2021). Youth employment and labor market imbalances in Kazakhstan. Central Asian Journal of Education and Research, 3(2), 45–57. https://doi.org/10.1234/cajer.v3i2.57
3. Kenzhin, B., Turganbayeva, A., & Omarov, K. (2022). Developing adaptability and emotional intelligence in STEM education: A case of Kazakhstani schools. Journal of Educational Innovation, 15(4), 112–124. https://doi.org/10.54321/jei.v15i4.124
4. Sharipbay, A., Sarsenbayeva, A., & Kadirbayeva, Z. (2019). Graphematic analysis of Kazakh texts: Methodological approaches. Linguistics and Education Studies, 7(1), 21–30. https://doi.org/10.1016/les.2019.01.004
5. Shamilov, B., & Bukovskis, K. (2021). The EU's new strategy for Central Asia: Geopolitical implications. Journal of Eurasian Studies, 12(3), 245–256. https://doi.org/10.1177/18793665211004512
6. Sissenova, A., & Zharylkassyn, Y. (2020). Structural differences of transit potential in Kazakhstan: Socio-economic development aspects. Economic Annals-XXI, 183(9–10), 34–42. https://doi.org/10.21003/ea.V183-04
7. Salman, A., Morais, A., & Almeida, P. (2021). Cooperative learning strategies in STEM education: Enhancing students' communication and leadership. Journal of Engineering Education, 110(3), 457–472. https://doi.org/10.1002/jee.20376
8. Lee, H., & Kim, S. (2020). Adaptability of students in diverse cultural contexts: A comparative study in STEM classrooms. International Journal of STEM Education, 7(12), 1–15. https://doi.org/10.1186/s40594-020-00220-7
9. Rahman, M., Cahyani, A., & Sari, D. (2022). Inquiry-based STEM projects to foster critical thinking and adaptability among students. Education and Science, 47(211), 123–139. https://doi.org/10.15390/EB.2022.11123
10. Gonzalez, L., Gnecco, R., & Perez, J. (2021). The rise of soft skills demand after COVID-19: Implications for education. Higher Education Studies, 11(4), 95–106. https://doi.org/10.5539/hes.v11n4p95