OPPORTUNITIES FOR MANAGING EDUCATIONAL ORGANIZATIONS: THE USE OF MOBILE ROBOTS TO IMPROVE THE EFFICIENCY OF UNIVERSITY ADMISSIONS CAMPAIGNS

OPORTUNIDADES PARA GERENCIAR ORGANIZAÇÕES EDUCACIONAIS: O USO DE ROBÔS MÓVEIS PARA MELHORAR A EFICIÊNCIA DAS CAMPANHAS DE ADMISSÃO EM UNIVERSIDADES

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Abstract. Revolutions in education have a great influence on the development paradigm of modern society. The guiding vector for its further improvement is the rapid development of the technosphere. The research objective is to identify effective methods and means of managing educational organizations in the context of further digitalization and intensification of accounting and methodological business processes. Our results, derived from document analysis and a qualitative case study, indicate that implementing the Turtle robotic avatar system can streamline university admissions campaigns, improving efficiency and user experience. The study emphasizes the importance of balancing technological integration with traditional spiritual and cultural values, ensuring that the deployment of intellectual technologies does not disrupt social cohesion. We propose a strategic framework for incorporating intelligent virtual avatars in educational processes, aiming to foster sustainable growth without exacerbating societal turbulence in an era of large-scale digital transformation.

Keywords: Gamification; Intelligent system; Applicant; Human-machine interaction; Information security.

Resumo. As revoluções na educação têm grande influência sobre o paradigma de desenvolvimento da sociedade moderna. O vetor de orientação para seu aprimoramento é o rápido desenvolvimento da tecnosfera. Ele afeta a atividade intelectual humana em todo o mundo, inclusive a noosfera e a biosfera, devido à digitalização total. O objetivo da pesquisa é identificar métodos e meios eficazes de gerenciar organizações educacionais no contexto de maior digitalização e intensificação dos processos de negócios contábeis e metodológicos. Os autores realizaram uma análise de documentos e um estudo de caso qualitativo para desenvolver um algoritmo para operar o sistema de avatar robótico Turtle.O artigo enfatiza a importância de manter um equilíbrio entre os valores espirituais e culturais tradicionais e as tecnologias intelectuais que substituem os funcionários da empresa. Os autores propõem uma possível estratégia para integrar um ser virtual inteligente (avatar) no processo educacional sem o risco de perturbar a coesão social ou agravar a turbulência com a digitalização em larga escala de todas as esferas.

Palavras-chave: Gamificação; sistema inteligente; candidato; interação homem-máquina; segurança da informação.

1. INTRODUCTION

One of the modern trends in education is realized within the concept of STEM (science, technology, engineering, and mathematics). The latter is a targeted program for training educators and scientists. This concept searches for an optimal solution to global problems related to migration, global conflicts, preserving biodiversity, supporting healthcare, changing climate conditions, and achieving the principles of sustainable development (Sergeeva et al., 2023). It is also more utilitarian and offers STEM as a tool for training the maximum number of competitive graduates from universities with natural science degrees (Hsieh et al., 2022).

Within the framework of this research, we proceed from the thesis that the "real student and machine teacher" model integrated with robotics in the field of education increases the importance of STEM. The formation of a professional is undergoing certain changes, due to an in-crease in the requirements and characteristics that must be met (Gabidullina et al., 2023). Accordingly, the material and technical support of the educational and methodological process should combine appropriate tools and methods. This requires increased control both on the part of educational organizations and the state. Considering the introduction of new technologies (the Internet of Things, nano technologies, artificial intelligence (Abdullaev et al., 2023a, 2023b)), it is important to identify the main aspects of integrating the results of technological progress into learning and knowledge management (as a new function of classical management) (Hernández García de Velazco, 2022).

The study aims to identify effective methods and means of managing educational organizations in the context of further digitalization and intensification of accounting and methodological business processes. This involves exploring innovative approaches to streamline administrative workflows, enhance data accuracy, improve decision-making, and optimize the use of digital tools and resources. By addressing these objectives, the study seeks to provide actionable insights for educational administrators to adapt to evolving technological demands, enhance operational efficiency, and support sustainable organizational development in a digital age.

2. LITERATURE REVIEW

Gamification (the systematic introduction of game activities into non-game contexts, for example, everyday life, school, and work) is perceived as a powerful educational tool. Many disciplines are being gamified to captivate students and hold their attention (Educators Technology, n.d.). From psychological and pedagogical viewpoints, gaming software, applications, and studies indicate that robots are good for maintaining the student's interest and facilitating better learning than formal material read out by a lecturer accompanied by a PowerPoint presentation.

A scientific study comparing a programming course using standard methods and using robotics based on LEGO® Mindstorms, Lego Education, and Arduino shows that the problem-solving skills and motivation of students who received a degree in programming using robotics were higher than the skills of those who obtained classic education in programming (Çam & Kıyıcı, 2022; Ybyraimzhanov et al., 2021).

Introducing elements and mechanisms of robotics into educational activities facilitates the search for gifted and talented youth, thereby stimulating the acquisition of skills that are in demand in the context of inevitable social changes (Eremeeva et al., 2024). American studies (Eguchi, 2015) touch upon issues related to ensuring effective learning by creating new educational and methodological technologies based on robotics to help talented students better demonstrate their skills (Eguchi, 2015).

Being a new and uncommon field for the majority of the population, educational robotics demonstrates the potential to stimulate students' interest in educational content (Batashev et al., 2023). Its purpose is to become an additional link in motivating and encouraging students to more actively participate in the learning process. Therefore, educational robotics are a great auxiliary tool when planning their classes (in particular, those where the result of intermediate certification is a differentiated assessment) (Yang et al., 2022). Robotic systems in the field of education fulfil several key roles: offer literature at the user's request (for example, Pepper from Softbank Robotics) (RoboTrends. (n.d.); select the most effective methods of individual training; assess knowledge in a course through control tests (for example, the Russian software of JRA by Promobot (2020)). This consolidates knowledge and in-creases interest not only in the principles of learning but also in the structure and content of the discipline (Voskresensky

et al., 2024). In this regard, many practical skills are acquired and developed through robotics-based immersion, which constitutes the STEM concept (Kiselitsa et al., 2024).

For deep integration into society, a social (i.e., socially active) robot must support gamification technology (for example, reward communication participants with points for giving the right answers) and have additional functionality, including positive non-verbal behavior (Zhelonkin et al., 2020). For example, distrust in robots caused Neo-Luddism and the rise of militant mysticism fueled by the Uncanny Valley effect (a phenomenon based on a hypothesis by Japanese roboticist Masahiro Mori that a robot or other object that acts or looks like (but not the same) as a real person causes disgust and hostility among human observers) (Sarankina & Strelnikov, 2021)). A robot appointing rewards can also emphasize the game element, solidifying its role as a mentor. Thus, the need for competence and connection can be further highlighted if time limits are respected to avoid cognitive overload and distraction from learning (Stepanova et al., 2021).

The literature review proves a growing interest in educational robotics which can be used at various levels (Ouyang, Xu, 2024).

3. METHODS

We conducted a study that included two stages: stage 1 was the analysis of documents, and stage 2 was a qualitative case study.

The document analysis comprised data from secondary studies conducted by HolonIQ and GeekBrains in collaboration with SberUniversity, in which all participants in the educational process took part (160 teachers and 612 students of universities and supplementary vocational education organizations) (Miszczak, 2023) and scientific articles on the research topic from eLIBRARY.RU, RSCI, Scopus, and Web of Science.

To optimize the educational process, we conducted a qualitative case study to optimize university admission campaigns. Enrollment is an important stage in the activities of many universities worldwide. It influences educational organizations in terms of the selection of future students and the quality of service, in which applicants get their first impressions of the entire organization. This confirms the significance of the chosen research topic.

In the course of the research, we aimed to create an integrated flexible educational and methodological software and hardware solution that fulfills the following tasks:

- To determine the input parameters and characteristics for selecting an effective strategy for conducting admission campaigns;
- To ensure the security of information resources and prevent potential threats and negative consequences for personal data and documents of applicants (loss, illegal profiling, distortion, blocking, etc.);
- To motivate and retain applicants with high scores upon admission;
- To support applicants in making well-informed educational choices and to ensure state-funded scholarships are directed toward those committed to their chosen field

We used a suite of STEM-based digital tools designed to streamline the processing of applicants' documents. This includes document scanning and verification software, machine learning algorithms for detecting inconsistencies, and secure data management systems to protect applicant information.

4. RESULTS

As the results show, humanities teachers were not enthusiastic about the introduction of educational robotics due to the lack of necessary knowledge, skills, and competencies. However, during their research, the respondents showed a significant interest in educational

robotics based on the Internet of Things, facilitating its implementation in the natural sciences (Brusilovskii & Pitelinskii, 2004) (Figure 1).

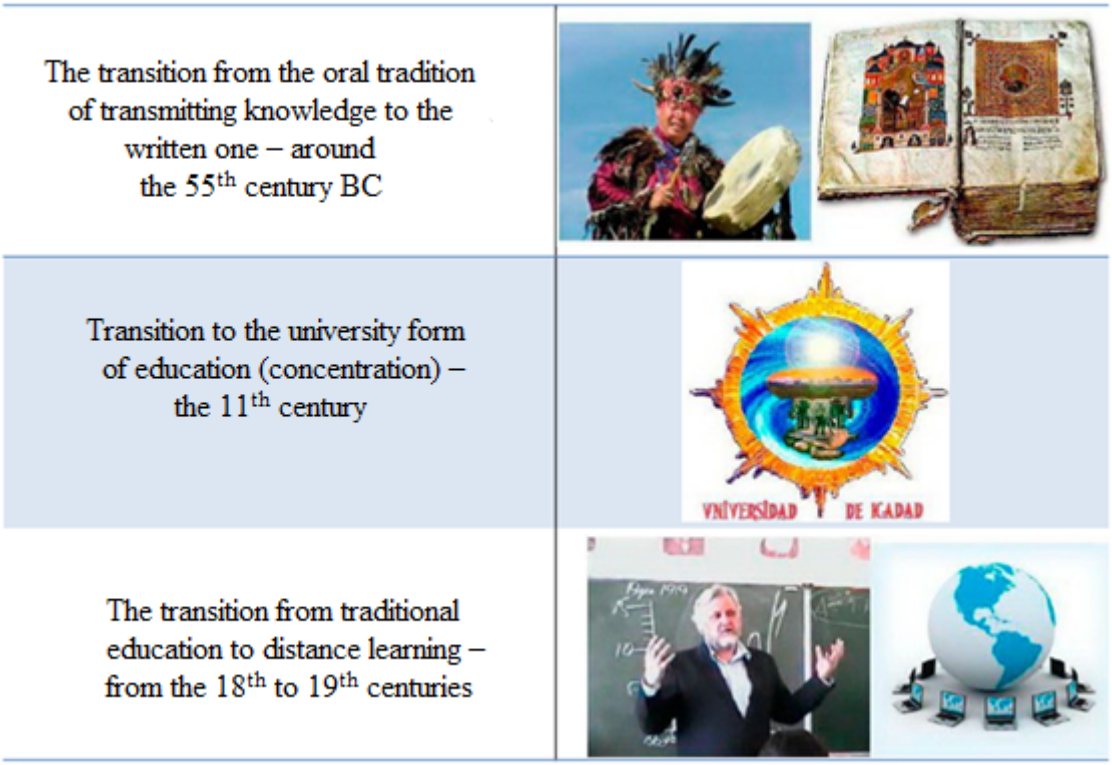

Figure 1. Educational revolutions (Brusilovskii & Pitelinskii, 2004)

According to statistics, there is a slight increase in the influence of AI. HolonIQ surveyed those that have already implemented similar solutions: their number grew by 25% in 2022 if compared to 2019. From this survey, 4% of companies (464 respondents) admitted to unsuccessful attempts to implement AI. In education, there are also noticeable trends of distrust in information technology. However, most respondents understand the need to introduce technology into the educational process.

We need to emphasize the high potential of AI in improving personalized learning and automating the solution of administrative tasks. However, the issues of psychological and personal self-development do not have a positive effect and still require solutions. The responses combined enthusiasm, caution, and potential risks to the development of analytical thinking. All this confirms a growing interest in using AI to revolutionize education (Figures 1 and 2).

Interpreting the survey results, we need to highlight a demand for the active involvement of technologies in the educational process since they save time (Baburin & Zemtsov, 2019).

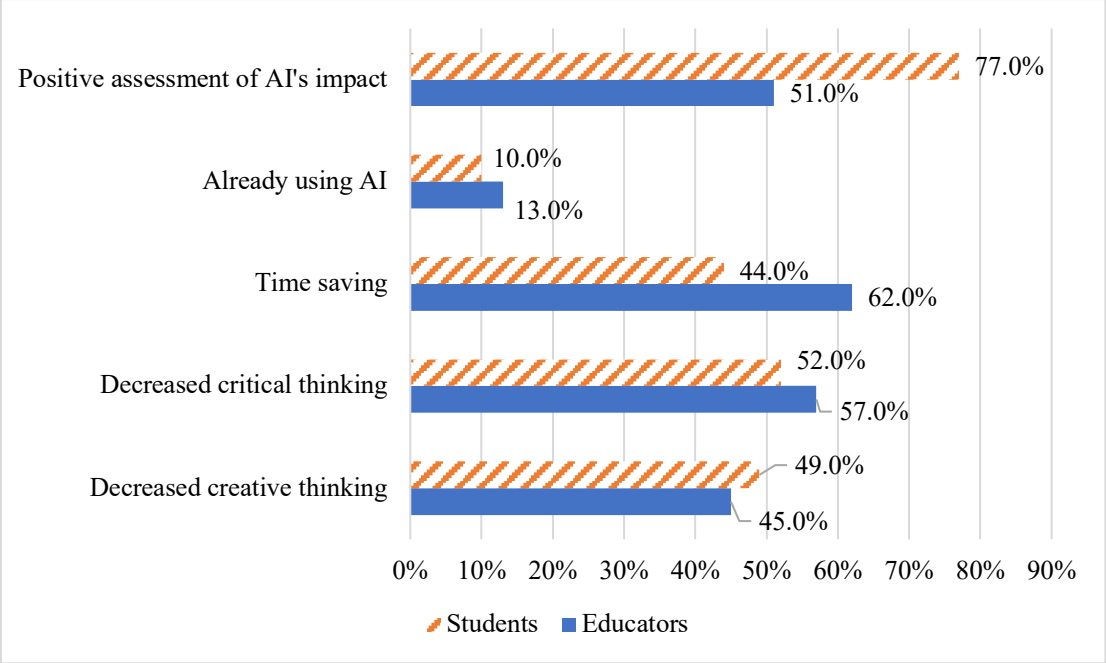

Figure 2. The attitude of participants in the educational process toward the introduction of AI (Forbes.Education, 2023)

As a result, we developed a prototype of a bionic robot (it is easier for a person to use such a solution if it looks as natural as possible, i.e., similar to what a person has already seen) in the form of a turtle. This robotic system operates within admission campaigns using navigation tools based on machine vision (to avoid obstacles), GPRS and Wi-Fi modules (for communication and navigation), a powerful video camera with a microphone and speakers (to ensure human-machine interaction), and a scanner of applications (inside a secure container with documents) for prompt recording in the university database and a biometric lock on the shell. Its concept map diagram is shown in Figure 3. The visual prototype is a hybrid of the Volkswagen Beetle (form) (Sketchfab, 2023), the 1918 French Renault FT-17 tank (tail stop technology) (Sketchfab, 2017), and the CyberTurtle bionic robot (kinematic principles of movement (UltiMaker Thingiverse, 2020) and design (UltiMaker Thingiverse, 2022)). It is promising to build communication between the turtle and the applicant using an AI system (for example, an advanced version of ChatGPT).

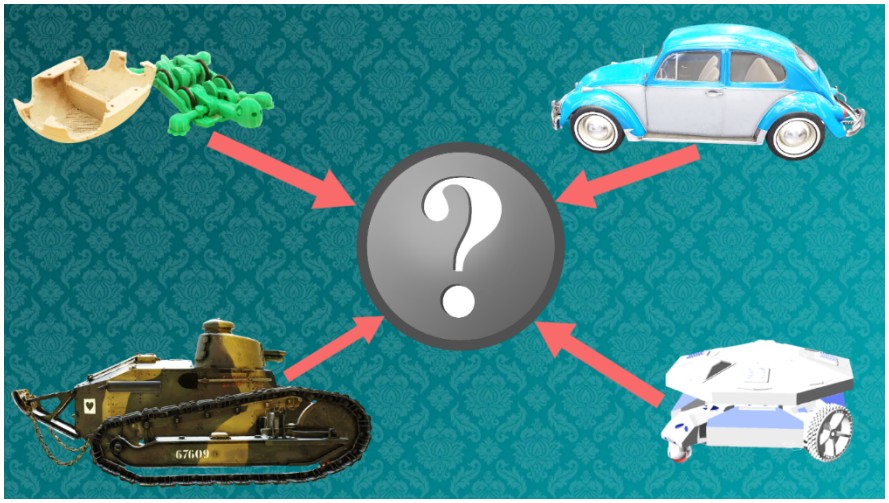

Figure 3. Concept of the robotic system.

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The reason for choosing a turtle avatar is philosophical and historical. The main symbolic meanings of the turtle archetype are wisdom and strength expressed in long-term patience, the ability to defeat a stronger opponent, longevity, achieving goals through slowness and caution, resistance to neuroses, and protection of the family hearth. Many cultures view the turtle as a symbol of wisdom and a guardian of knowledge, often representing longevity, patience, and resilience (Pitelinskii, 2018). In the future, such turtles and other bionic (animal-like) robots will become avatars (material carriers) of reference data, historical information, and unique traditions for each educational organization.

The Turtle robotic avatar system can be integrated into the role-playing intelligent system of a smart building (as a subsystem of a smart university). Planning the movement of the Turtle with autonomous control fulfills the goal of moving the robot in the environment using computer vision and AI elements, which can be interpreted as job responsibilities (to determine optimal route trajectories along the way, avoid obstacles, and perform a certain set of tasks). The development of a navigation system for the Turtle requires complex algorithms, including additional components: data analysis algorithms (processing a large amount of information, in particular, for orientation in the environment) and sensors (cameras, navigators, laser range finders, etc.) helping to obtain information about the external environment for making decisions in real time (Tsapin & Pitelinskii, 2022).

Robot navigation techniques continue to evolve and increase their potential. These include the RRT and D* algorithms designed to plan the highest priority path with due regard to possible restrictions and personal preferences of the user; a proportional-integral-differentiating controller that distributes the load on the engine and other components of the Turtle; the chosen trajectory of movement and the specified goal; localization methods (for example, SLAM (Simultaneous Localization and Mapping), maximum likelihood estimation, etc. (Tsapin & Pitelinskii, 2022, 2023)). This allows the robot to navigate in physical space and know its location. Machine learning methods help predict (and therefore plan) the necessary behavior of the robot on a training model and possible obstacles on the optimal path of movement selected before (Rodionov, 2023).

Other tasks of admission campaigns can be implemented through methodological support in the form of a survey with the further verification of the results obtained not by a person but by a decision-making system, whose interface is the Turtle. Its neural network must operate according to an algorithm that considers not only the answers in the application but also unique information (personal achievements, age, gender, family composition, health status, other benefits or merits, etc.).

Integrating the Turtle system into the admissions process has the potential to enhance student engagement and streamline the enrollment experience, which may positively impact university enrollment outcomes, strengthening the role of teaching, methodological, and scientific-educational activities in modern society and combining it with the long-term training of highly qualified specialists for various sectors of the economy.

Submitting documents to the Turtle introduces game elements in the strict process of an admission campaign. The algorithm for its operation is given in Table 1.

Table 1. Algorithm for the Turtle

No.	Structure of activities
Step 1	Activating the Turtle at the beginning of a working day
Step 2	Scanning the university environment to identify the next applicant by gestures and voice
Step 3	Navigating inside the university building and moving toward applicants
Step 4	Greeting the applicant in a humorous manner
Step 5	Scanning documents (passport, high school diploma, certificate, etc.) accompanied by voice instructions to the applicant
Step 6	Issuing an enrollment form from the compartment in the back to be filled out manually by the applicant

Step 7	The certified document is scanned and placed in a secure compartment under the turtle's shell
Step 8	The Turtle, if necessary, provides the applicant with the necessary information and answers questions
Step 9	The Turtle says goodbye to the applicant and returns to Step 2
Step 10	When the application compartment is filled, the Turtle goes to the admission office to unload completed forms and to load blank forms, after which returns to Step 2
Step 11	If necessary, the Turtle recharges at the electric feeder, after which returns to Step 2
Step 12	At the end of a working day, the Turtle enters the admission office and goes into sleep mode, ready for Step 1

5. DISCUSSION

Apart from discussing specific technical issues, which is beyond the scope of this study, we would like to dwell on the social opportunities and implications of implementing robotic systems like the proposed Turtle avatar system.

Despite the already established innovative approach to the implementation of technologies (powerful AI-based systems, humanoid robots, virtual augmented reality, etc.), the effective use of robotic systems requires attention to the intermediate (explanatory) link in the form of preparing society and individual users for innovation, especially within educational organizations. This can lead to problems in their implementation, which can slow down the formation of the technosphere. A challenge in the development of robotics is the profitability of a robotic complex and its operation since it is not immune to vandalism. The emergence of robots with the subsequent displacement of humans from several professions will lead to robophobia (an intense tendency to refuse such technical solutions due to insufficient trust in them) (Zelenkov et al., 2024).

The study also underscores the importance of addressing ethical and psychological concerns associated with robotic integration: demand avoidance, psychological stress, the need for frequent professional retraining, an age limit, etc. (Suiunalieva et al., 2024). The wind of change is felt in trade, industry, agriculture, transport, banking, medicine, and education. These findings suggest that integrating robotic systems in education may require structured support systems to mitigate these challenges.

From a regulatory perspective, the lack of specific legal frameworks for AI and robotic use in education could impede progress. Our research points to the importance of establishing clear legal guidelines to support responsible and secure AI applications within educational institutions. But currently, there is no special legislative regulation that considers the use of AI in the field of education (Osmonbaeva et al., 2024; Sultonova et al., 2023). The legal activities of robotic systems should be studied individually, with due regard to their national application (Nikolaeva et al., 2024). At the moment, the legislative framework for this type of activity is not sufficiently formed both at the national and global levels (some legislative initiatives should be ratified).

Despite high demand, the intelligent ecosystem and automation of human activity will require further adaptation and improvement of the security system not to create, together with a useful multidisciplinary robot, another potential threat to humans.

6. CONCLUSIONS

To effectively develop the educational system, it is necessary to implement software and hardware solutions that support deep integration with information, communications, and other technologies. However, it is important to preserve spiritual and moral values within educational organizations (for example, among the teaching staff to show congruence, moderate trust, empa-thy, authority, and professional competence; among students – mutual respect, motivation to gain knowledge, increase professionalism, and preserve cultural values, cohesion, and the desire to reveal their talents; among the educational and support staff –

collectivism, the ability to encourage professionals, competence, the ability to find a timely compromise, etc.).

Technological progress in a modern turbulent world cannot be stopped. However, each individual should preserve the ability to interact with society properly. The hope of a bright future should not be connected with an anthropomorphic know-it-all (a soulless robot servitor) that can satisfy the individual's need for communication but not imitate harmonious interpersonal relationships.

Since the early 21st century, society has retained its structure and main vectors of development but, with the acquisition of dynamism and flexibility in the era of digitalization, personal values have become more important, forming leadership qualities and putting a person on the path of harmonious convergence of technological progress and eternal moral values (i.e., the preservation of the basic values based on Immanuel Kant's categorical imperative).

The proposed solution for conducting an admission campaign in an educational organization with the help of mobile robots (Turtle) allows expanding the use of gamification technology, involving applicants in student life, ensuring the safe transmission of data streams, and providing professional assistance in modern conditions (after identifying factors) when creating a high-quality model of career guidance, considering potential changes in the structure of society, education, and legislation, as happened during the COVID-19 epidemic.

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