THE ROLE OF TECHNOLOGY IN DEVELOPING SUSTAINABLE DEVELOPMENT COMPETENCIES IN STUDENTS

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Abstract
The article examines the modern role of the subject "Technology" in the education system and the issues of developing sustainable development competencies among students. The author provides a scientific analysis of approaches aimed at fostering ecological awareness, economic culture, and social responsibility within the process of technological education. Furthermore, a comparative study of national and international scholars’ perspectives is presented, and effective methods for enhancing sustainable development skills in students are proposed.

Introduction. In the 21st century education in the process human capital development, creative thinking shaping and sustainable to develop redirect issues current is considered. Uzbekistan Education in the Republic of in the field done increasing reforms, in particular, general middle education in schools technology science to be trained this to goals service Technology lessons through in students not only practical skills, maybe ecological, economic and social responsibility Understanding is also formed. Technology science students labor culture promotion, professional advancement interest increases and them society active member as in upbringing important factor is considered. Therefore, this in the article technology science stable development competencies in formation place analysis will be done.

Sustainable development competencies. Sustainable development competencies encompass a set of abilities that enable individuals to act responsibly towards the environment and society. These include:

- Systems Thinking: Understanding complex interactions within ecological, economic, and social systems.
- Anticipatory Competence: Predicting and assessing future scenarios and consequences.
- Normative Competence: Evaluating ethical dimensions and making value-based decisions.
- Strategic Competence: Planning and implementing sustainable solutions.

- Collaboration: Working effectively across disciplines and cultures.

Developing these competencies requires interactive and experiential learning approaches, where technology can play a transformative role.

The role of technology in sustainability education. Technology enhances sustainability education by providing dynamic, immersive, and accessible learning environments. Key roles include:

- Interactive Simulations and Virtual Labs: Tools that simulate environmental processes and human impact help students visualize and experiment with sustainable practices without real-world risks.
- Data Collection and Analysis Tools: Sensors, apps, and software enable students to gather real-time environmental data (e.g., air quality, energy consumption), fostering inquiry-based learning.
- Collaborative Platforms: Online forums, social media, and project management tools support teamwork and global collaboration on sustainability projects.
- Access to Global Knowledge: Digital libraries, MOOCs, and expert webinars provide up-to-date information on sustainability challenges and innovations.
- Gamification: Educational games motivate students to engage with sustainability concepts through problem-solving and role-playing scenarios.



Figure 1. Key competencies and performance of sustainability citizens

Technology holds significant promise in developing sustainable development competencies among students. When effectively integrated, it can provide experiential learning opportunities that cultivate critical skills needed for sustainable futures. Policymakers, educators, and stakeholders must collaborate to overcome challenges and create inclusive, technology-enabled learning environments that empower students to become responsible global citizens.

Literature analysis. Technological of education relevance about many foreign and local scientists own in their research stopped past. In particular, J. Dewey's concept of "Learning by Doing" in education practical activity reinforcement through person's independent thinking ability to develop accent P. Drucker gives technology and innovation education in the process to apply modern society development basis as shows.

From Uzbekistan researchers A. Jo'rayev, M. Tursunova and D. Shodmonova technology science in students labor qualification development, national handicraft study and ecological culture in formation importance illuminating those who gave.

Literature analysis to do this shows that technology science not only professional skills forms, but in students stable development principles suitable vital It also educates views.

Main part. Technology education through stable development competencies formation three main in the direction done increased :

1. Ecological competence – in students to the environment relatively conscious relationship formation, waste again work, resources reasonable use skills to give

2. Economic competence – to students thrift, labor fertility increase, own labor to the product responsible relationship to teach

3. Social competence – in the team work, professional labor in the activity social responsibility understanding, society for useful ideas previously push

Table 1. Analytical comparison of technology tools and their impact on sustainable development competencies

Technology Tool	Competencies Developed	Educational Benefits	Implementation Challenges
Simulation Software	Systems thinking, anticipatory competence	Visualizes complex systems, allows risk-free experimentation	Requires technical skills, expensive licenses
Data Collection Apps & Sensors	Inquiry skills, critical thinking, data literacy	Enables real-time environmental data	Access to devices, data accuracy, maintenance

Technology Tool	Competencies Developed	Educational Benefits	Implementation Challenges
		collection and analysis	
Collaborative Platforms	Collaboration, communication, ethical decision-making	Facilitates teamwork and global knowledge exchange	Internet dependency, digital literacy gaps
Gamified Learning Tools	Motivation, problem-solving, strategic competence	Increases engagement and active learning	Possible distraction, requires balanced integration
Virtual Reality (VR) / AR	Systems thinking, empathy, experiential learning	Immersive experiences of environmental impacts	High cost, hardware limitations
Project-Based Learning (PBL) Tools	Strategic competence, creativity, collaboration	Promotes hands-on, real-world problem solving	Time-consuming, demands curriculum adaptation

Technology in science innovative from methods use – project based on education, problematic situations solution, group works and practical classes – students to activity This process is their independent decision acceptance to do, creative thinking and new approaches working exit qualification develops.

Also, national to values-based approaches – Uzbek people handicraft, traditional labor types and modern of technologies harmony – students spiritual and moral also important in maturation importance profession will reach.

Research discussion. The integration of technology into sustainability education presents a transformative opportunity for cultivating essential competencies in students. The findings suggest that digital tools significantly enhance students' ability to understand and engage with complex sustainability challenges by making abstract concepts more tangible and interactive. For instance, simulations and virtual labs allow learners to experiment with environmental scenarios safely, fostering deeper systems thinking and anticipatory competence. These experiences are crucial in helping students grasp the interconnectedness of ecological, social, and economic systems, which lies at the heart of sustainable development.

Moreover, technology facilitates active, student-centered pedagogies such as project-based and inquiry-based learning. Through collaborative platforms and

data collection tools, students are encouraged to take ownership of their learning, engage in problem-solving, and work cooperatively with peers both locally and globally. This aligns with the normative and strategic competencies, enabling learners to evaluate ethical implications and devise actionable solutions to real-world problems.

However, the discussion also acknowledges the persistent challenges in effectively leveraging technology for sustainability education. The digital divide remains a significant barrier, particularly in underserved communities, potentially exacerbating educational inequalities. Without equitable access to technological resources, many students miss out on these enriched learning experiences, which can hinder the development of sustainability competencies across diverse populations.

Additionally, teacher readiness is a critical factor. Educators must possess not only technical skills but also pedagogical strategies to integrate digital tools meaningfully into their instruction. The current gap in professional development opportunities limits the potential impact of technology on sustainability education.

Curricular limitations further complicate this landscape. Many education systems have yet to embed sustainability competencies and technology use cohesively within their frameworks, often treating them as supplementary rather than integral components. This fragmentation reduces the effectiveness of digital interventions and may lead to superficial engagement rather than profound competency development. While technology offers powerful avenues for advancing sustainability education, its success depends on systemic support, including infrastructure investment, teacher training, and curriculum reform. Future research should explore scalable models for integrating technology equitably and effectively, ensuring that all students can develop the competencies needed to contribute to a sustainable future.

Conclusion and recommendations. Technology science in students stable development competencies in formation place is incomparable. Through this science students ecological, economic and social responsibility deeper realizing they will reach. In the article held to analyzes relied on without following recommendations to give possible:

technology in science stable to develop related special modules current to grow;

lesson in the process project based on educational and practical training expansion;

national and international experiments harmonized without innovative methodologies application;

in students ecological and economic culture to form aimed at integrated lessons organization.

REFERENCES

1. Dewey J. Democracy and Education. New York: Macmillan, 1916.
2. Drucker P. Innovation and Entrepreneurship. Harper & Row, 1985.
3. Jo'rayev A. “ Technological in education labor qualifications develop methods ” // Uzbekistan pedagogy magazine, 2021.
4. Tursunova M. “ Craftsmanship the basics in teaching innovative approaches ” // Education and Innovation, 2022.
5. Shodmonova D. “ Technology in education ecological culture formation ” // Scientific information collection, 2023.
6. UNESCO. Education for Sustainable Development Goals. Paris, 2017.
7. Uzbekistan Republic of " Education" "about" Law. T., 2020.