Aspect of intellectual development in technical education

Bahram Tadjibaev [a)], Golibjon Arzikulov, Gulnoz Abdikayimova

Tashkent state technical university named after Islam Karimov, Tashkent, Uzbekistan

[a)] *Corresponding author: baxromtadjibaev58@gmail.com*

Abstract. The aim of this article is to describe the main aspects of intellectual development in the field of technical education. Without intellectual development, technical education loses its depth and practical value. These aspects together form deep understanding, and professional competence. A comprehensive study of promising directions in the development of technical education if important for understanding technical processes, helps to find original approaches, and improves existing engineering technologies.

INTRODUCTION

The main aspects of intellectual development in the field of technical education include critical thinking as the ability to analyze and evaluate information, as well as logical thinking as the process of constructing clear and consistent reasoning. The generation of new ideas and unconventional solutions is achieved through the development of creative thinking. It if also important to acquire skills for finding effective ways to overcome difficulties. A key it the ability to seek and master new knowledge lies in self-directed learning, and the application of theory to real technical problems forms the basis of practical implementation.

MAIN PART AND RESULTS

The multifaceted nature of modern technical education refers to its multi-aspect character, encompassing different levels and directions of training.

This means that technical education covers:

- Theoretical knowledge of fundamental sciences (mathematics, physics, etc.)
- Practical skills in working with equipment and technologies
- Engineering thinking and design
- Use of modern information technologies
- Development of communication and management skills
- Attention to ethical and environmental aspects

Such education prepares specialists capable of solving complex problems in various fields of engineering and industry, taking into account not only technical but also social, economic, and environmental factors.

The multidirectionality of modern technical education refers to the presence of multiple directions and approaches in specialist training.

It implies that education covers various vectors of development, such as:

- Technical and engineering knowledge
- Information technology and digitalization
- Project and innovation management
- Interdisciplinary connections with other sciences and industries
- Development of teamwork and communication skills
- Consideration of social and environmental requirements

This approach allows preparing versatile specialists capable of adapting to the rapidly changing world of technology and economy.

Social and environmental requirements as an important direction in the multidirectionality of modern technical education emphasize the need to train specialists who consider the impact of technology on society and the environment.

This includes:

- Awareness of social responsibility among engineers and technicians
- Development of sustainable and environmentally safe technologies
- Implementation of sustainable development principles in projects and production
- Consideration of ethical aspects when creating new technical solutions
- Analysis of the impact of technical innovations on human health and well-being

This vector helps form specialists capable of creating technologies that harmoniously align with the needs of society and nature.

Interdisciplinary connections with other sciences and industries as an important direction in the multidirectionality of modern technical education highlight the integration of knowledge and methods from various fields to enhance specialist training.

This includes:

- Collaboration between engineering, natural sciences, and social sciences
- Application of cross-disciplinary approaches to solve complex technical problems
- Incorporation of insights from economics, management, and environmental studies
- Promotion of innovation through the combination of diverse expertise
- Preparation of specialists capable of working in multifaceted and evolving technological environments

Such a direction fosters versatile professionals ready to address challenges at the intersection of different disciplines and industries.

The role of intellectual development in technical education is that it:

1. Promotes the development of analytical and critical skills.
2. Helps effectively solve complex technical problems.
3. Stimulates creative approaches and innovation.
4. Provides the ability to adapt to new technologies.
5. Form a systemic and deep understanding of technical processes.

Scientists working in the field of intellectual development in technical education come from various disciplines such as pedagogy, psychology, engineering, and cognitive sciences. Some notable researchers include:

1. Jean Piaget's theory of cognitive development influences the understanding of learning and is published in several of his key works [1, 2, 3, 4].

2. Benjamin Bloom developed the taxonomy of educational objectives important for intellectual development. The taxonomy of educational objectives, published by him in the book "Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I: Cognitive Domain" [5] – this is the main publication in which his classification of educational objectives in the cognitive domain is described in detail.

3. John Dewey contributed to the theory of learning through experience. In his book "Experience and Education" [6] he elaborates on his ideas about the importance of experience in the learning process.

4. Herbert Simon' research decision – making and artificial intelligence is published in several of his works [7, 8]. The key one being "Models of Man: Social and Rational". Also important is his article "Administrative Behavior", where he examines decision – making in organizations and the foundations of artificial intelligence.

5. Donald Schon researched reflective thinking in professional education. Reflective thinking in professional education, studied by Donald Schon, is published in his book "The Reflective Practitioner: How Professionals Think in Action" [9].

These are just a few scientists whose work helps develop intellectual abilities in technical education.

Now we will move on to a detailed description of the aspects of intellectual development.

Critical thinking in technical education is the ability to analyze, evaluate, and make reasoned decisions on technical tasks using logic and objective data. It helps students not just memorize information but deeply understand processes, identify errors, and find optimal solutions in their professional field [10-15].

Logical thinking in technical education is the ability to analyze information sequentially and systematically, make reasoned conclusions, and solve problems based on rules of logic. It is important for understanding technical processes, developing algorithms, and making correct engineering decisions.

Creative thinking in technical education is the ability to generate new ideas, approach technical problems unconventionally, and create innovative solutions. It helps to find original approaches and improve existing technologies.

Problem – solving skills in technical education are the ability to identify technical issues, analyze them, and develop and apply effective methods to resolve them. These shills include critical thinking, the use of technical knowledge, and practical tools to achieve results.

Self – directed learning in technical education is the process where a student independently organizes their study of technical subjects using available resources such as textbooks, online courses, and practical exercises. It promotes the development of responsibility, independence, and the ability to find information and solve problems without consultant instructor support.

Practical application in technical education if the use of theoretical knowledge in practice through performing real tasks, experiments, projects, and technical work. It helps to reinforce skills, understand the operation of equipment and technologies, and prepare for professional activities.

Intellectual development through the development of technical thinking means that the improvement of mental abilities occurs by forming skills in analysis, logic, solving technical problems, and creativity in the technical field. In other words, by developing technical thinking, a person learns to approach problems systematically, apply knowledge in practice, and find innovative solutions, which overall contributes to intellectual growth [16-18].

Technical progress significantly accelerates the intellectual development of the entire scientific community. It provides new tools and research methods, facilitates access to information and knowledge exchange, and stimulates the emergence of innovative ideas and interdisciplinary approaches. As a result, scientists can solve more complex problems, expand the boundaries of knowledge, and advance science more rapidly.

To accelerate technical progress in modern society and education, it is necessary to:

1. Investing in science and education — funding research and developing talents.
2. Collaboration between scientists, engineers, and businesses — sharing ideas and resources.
3. Supporting startups and innovative companies — creating a favorable environment for new technologies.
4. Developing infrastructure — providing access to modern laboratories and technologies.
5. Promoting science — increasing public interest in technical achievements.

This is how technical progress can be accelerated in society.

CONCLUSIONS

Technical education contributes to the formation of a systematic and deep understanding of technical processes through studying theory, practical exercises, and solving real-world problems. It teaches how to analyze processes, develop algorithms, and apply knowledge to make well – founded engineering decisions. Thus, students acquire critical thinking skills and a systematic approach necessary for effective work in the engineering field [19-22].

Ensuring intellectual development in technical education requires a harmonious combination of modern technologies and individualized approaches.

To develop new educational technologies for intellectual development in the field of technical education, it is advisable to:

1. Increase interactivity — organize lessons where students actively participate and focus on problem-solving.
2. Flexible curricula — create individual learning paths tailored to each student's abilities and needs.
3. Integrate digital technologies — enrich the learning process with virtual labs, simulations, and artificial intelligence.
4. Project-based learning — develop practical skills by solving real-life problems.
5. Continuous teacher training — organize training sessions on effective use of new technologies.
6. Collaboration and networked learning — promote knowledge exchange and cooperation among students and experts.

REFERENCES

1. J. Piaget, *The Language and Thought of the Child* (Harcourt, Brace and Company, New York, 1932), 230 pp.
2. J. Piaget, *The Child's Conception of the World* (Harcourt, Brace and Company, New York, 1926), 270 pp.
3. J. Piaget, *The Origins of Intelligence in Children* (International Universities Press, New York, 1936), 400 pp.
4. J. Piaget, *The Construction of Reality in the Child* (Basic Books, New York, 1954), 280 pp.
5. B. S. Bloom, *Taxonomy of Educational Objectives: The Classification of Educational Goals, Handbook I: Cognitive Domain* (David McKay Company, New York, 1956), 320 pp.
6. J. Dewey, *Experience and Education* (Kappa Delta Pi, New York, 1938), 80 pp.

7. H. A. Simon, *Models of Man: Social and Rational* (Wiley, New York, 1957), 280 pp.
8. H. A. Simon, *Administrative Behavior* (Free Press, New York, 1976), 600 pp.
9. D. A. Schön, *The Reflective Practitioner: How Professionals Think in Action* (Basic Books, New York, 1983), 374 pp.
10. A. Yusupov, G. Arzikulov, and D. Buvasherov, "Experiences in teaching mathematics in engineering education," *AIP Conf. Proc.* **3331**, 030081 (2025). https://doi.org/10.1063/5.0306675
11. A. Yusupov, S. Pirmatov, B. Kholkhodjaev, and E. Esanov, "Science in the training of energy engineers on the basis of personalized educational technologies," *AIP Conf. Proc.* **3331**, 030083 (2025). https://doi.org/10.1063/5.0305989
12. D. Shamsiev, A. Abdukarimov, U. Rakhmonov, and R. Duisenbayev, "Solution of a dynamic problem of a hereditary deformable cylinder with variable parameters," *AIP Conf. Proc.* **3331**, 030088 (2025). https://doi.org/10.1063/5.0307049
13. B. Tadjibaev, "Characteristics of intellectual work defining new technologies," *AIP Conf. Proc.* **3331**, 040007 (2025). https://doi.org/10.1063/5.0305753
14. D. H. Autor, "Why are there still so many jobs? The history and future of workplace automation," *J. Econ. Perspect.* **29**(3), 3–30 (2015). https://doi.org/10.1257/jep.29.3.3
15. J. Abdullayev, U. Rakhmonov, and N. Mahmudova, "Orthonormal system for a matrix ball of the second type and its skeleton (Shilov's boundary)," *Asia Pac. J. Math.* **10**, 27 (2023). https://doi.org/10.28924/APJM/10-27
16. D. H. Autor, "The 'task approach' to labor markets: An overview," *Labour Market Research* **46**, 185–199 (2013). https://doi.org/10.1007/s12651-013-0128-z
17. J. B. McOmber, "Technological autonomy and three definitions of technology," *J. Commun.* **49**, 137–153 (1999). https://doi.org/10.1111/j.1460-2466.1999.tb02809.x
18. A. Abdukarimov, U. S. Rakhmonov, and F. Z. Turaev, "Dynamic response of the system to external influences," *AIP Conf. Proc.* **2612**, 030017 (2023). https://doi.org/10.1063/5.0117527
19. U. S. Rakhmonov, A. Abdukarimov, and Sh. Rajabov, "Calculation of inherently deformable pipelines lying on a solid viscoelastic base with random characteristics," *AIP Conf. Proc.* **2612**, 030016 (2023). https://doi.org/10.1063/5.0117526
20. J. K. Liker, C. J. Haddad, and J. Karlin, "Perspectives on technology and work organization," *Annu. Rev. Sociol.* **25**, 575–596 (1999). https://doi.org/10.1146/annurev.soc.25.1.575
21. W. J. Orlikowski and S. V. Scott, "Sociomateriality: Challenging the separation of technology, work and organization," *Ann. Acad. Manage.* **2**, 433–474 (2008). https://doi.org/10.1080/19416520802211644
22. D. J. Scott, "Learning technological concepts and developing intellectual skills," *Int. J. Technol. Des. Educ.* **7**(1), 161–180 (1997). https://doi.org/10.1023/A:1008861003553