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FROM POLYTECHNIC THROUGH DUAL TO STEAM TRAINING OR "ON NOVEL INNOVATION" IN EDUCATION

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Abstract. The Bulgarian education system has been under intense public scrutiny and been "enjoying" special attention from society since the fall of socialism in 1989. Several reforms have been implemented and continue to be made. Bulgarian education is being modernized gradually and purposefully. This is evident not only from the conditions in which the modern teacher works, but also from the new curricula that aim to equip Bulgarian students competent and ready for tomorrow. However, are these "new and innovative" ideas, or are they merely recycled and rebranded versions of past concepts? Are they being refined and expanded upon, or simply repackaged under a modern "educational facades of pseudo-innovations"? This article examines the essence of polytechnic education and traces the development of this concept to modern models of project-based learning, dual training, and STEAM education. The hypothesis is made that Bulgarian vocational education has always built upon the idea of the connection between theory and practice, and if, during the socialist system, the idea of polytechnicism linked education with production, now dual training is what provides personnel for various spheres of the economy, and in STEAM education, we rediscover the core principles of this long-standing idea.

Keywords: polytechnicism; dual education; STEAM education.

"*If we don't know history, we are doomed to repeat it*."
George Santayana

Introduction

Guided by one or another political idea, the society nowadays categorically condemns certain principles, statements and models, until similar analogues to the rejected ones "emerge" as "novel and new" ones that are proposed later in time. Sometimes these ideas are "imported from outside" as good and working practices and educational nostrums. A few decades ago, it was from the East, and now from the West. However, before we accept these "new" and innovative ideas, it is good

to look back, delve into history and assess whether they are not forgotten old or evolved as a result of new social conditions.

A similar trajectory may have characterized the evolution of *polytechnicism*. This article does not aim to rehabilitate it but rather to offer a historical and pedagogical analysis, enlightening the Bulgarian—and more broadly, Slavic—contribution as a precursor to many so-called "new" concepts and frameworks. In some cases, these ideas have either paralleled developments in other parts of the world or emerged independently. In reality, many of the models, principles, approaches, methods, and theories now hailed as innovative or groundbreaking are, in essence, the foundational elements of polytechnicism.

Polytechnicism has been the subject of research by many scholars since its inception to the present day. According to A. D. Maydanskiy, it is a principle *directly related to the solution of two meta-tasks of "scientific socialism": the culture of a multifaceted, harmoniously developed individual and the withering away of the state* (Maydanskiy 2022, p. 177). As J. Semrad and M. Skrabal emphasize , " The issue of polytechnic education gained importance in the first half of the 20th century, emerged as a crucial problem in the second half of the 20th century, and became a highly topical issue at the beginning of the 20th century, that is, at the time of what is described as a post-industrial, information society and/or learning society, or a knowledge-based society, especially in connection with the increasing number of scientific discoveries and the development of sciences, the strict focus on the so-called economic growth, the transformation of labor (digital technologies), and the new structuring of society." (Semrad 2017, p. 55). M. Skatkin considered it as a separate type of education, along with general and vocational education in the Soviet state. According to him, "polytechnic education introduces the student to the main branches and scientific foundations of production and teaches him to use the most common tools and instruments." (Shapovalenko 1964, p. 16)

Polytechnicism can be considered a comprehensive concept that emphasises the integration of different disciplines, especially in the field of science and technology. The main idea is to provide students with a holistic and comprehensive understanding of the world by combining knowledge from various sciences and technologies in the context of actual industry branches. This includes scientific, technical, mathematical and engineering disciplines, as well as their application in practice. The idea of polytechnicism in a historical aspect is connected with the concept of labour training. According to J. Semrad and M. Skrabal, polytechnicism is close to the ideas of J.A. Comenius, J. Pestalozzi, N. Krupskaya, P. Blonsky, G. Kirschensteiner, etc. As St. Stefanov points out, "The basis of the entire philosophical system of Jan Amos Comenius is pansophy... According to Comenius' ambition, the pansophia should "teach everyone everything and from every point of view" (Stefanov 2011, p. 176). Similar are the ideas of N. Krupskaya, who said: "Love for work can be educated through Work itself!", and when selecting the content of

the training, "it must change periodically and be a function of the socio-economic conditions" (Krupskaya 1925, p.104). Pavel Blonsky is among the representatives of labor pedagogy and is an advocate of industrial-labor school. According to him, school should be organized like life and children's interests should be placed at its center. G. Kireshensteiner also raises as a fundamental principle the participation of students in labor activity, the development of their manual skills and habits

In fact, the idea of J.A. Comenius to teach everyone everything was transformed and still resonates mighty today. Even in 1979, the long-time first secretary of socialist Bulgaria linked it to polytechnic education, saying: "... the polytechnic school educates and prepares the person, gives him the key to a wealth of knowledge, as well as teaches him how to learn" (Zhivkov 1979: 64). In 1996, in his report "Education – the Hidden Treasure", Jacques Delors formulated the four pillars of education: learning to know, learning to act, learning to live together and learning to be. For decades, we have also been talking about lifelong learning.

Polytechnicism as a model for organizing education is widespread in a number of countries. Evidence of this is analogous models for the specified period in Western Europe and in the USA as examples of its effectiveness. In his article "On the preparation of students for work in schools in Finland", M. Zhivelov mentions that in Finland every school has modern offices with various techniques, and there are classes from the programs for students, in which "through observation of older students, one influences the direction to a certain profession" (Zhivelov 1958). V. Klepkov, with many translated examples, describes how in Chinese schools they prepare from a young age and profile children into three levels based on the degree of interest and speed of mastering a given technical field, taking into account the economic benefits for the state. According to the author, in China, they have "achieved a complete connection of school with life, of theoretical knowledge with production tasks" (Klepkov 1959). There are similar articles for Hungary (Kalmar 1961), Czechoslovakia (Paloš 1960), Poland and the GDR. For Italy, Fadin says that "all students are introduced to the industry of Italy in three main aspects: 1. Methods of work. 2. Tools and machines. 3. Materials and raw materials, with students having practical work in the characteristic regional sectors of the national economy" (Fadin1957). Additional explanations for polytechnicism in Italy are also given by Khahilev (1957), who points out that at the national level, there is a division into three forms of polytechnic education: 1. Training in a craft; 2. Agricultural work and 3. Domestic and household work activities. He explains that the curricula in the upper secondary education level and the subjects are not mandatory, but a choice is made according to the conditions and possibilities of the school, as well as regional traditions and sectors.

In Bulgaria, the idea of polytechnicism comes from the Soviet Union and finds normative reflection in the Law for a Closer Connection of School with Life and for the Further Development of National Education in the People's Republic of

Bulgaria (People's Republic of Bulgaria – our note). Article 1 states that: "The school prepares well-educated, comprehensively and harmoniously developed people, giving them the necessary knowledge in the basics of the sciences, forming in them a Marxist-Leninist worldview, providing them with labour, polytechnic and professional training, physical, aesthetic and moral education. The school fulfils its tasks by ensuring a reasonable combination of work and study with rest and care for the normal physical development of children and adolescents." (Law on a Closer Connection of School with Life and for the Further Development of Public Education in the People's Republic of Bulgaria) This led to the opening of secondary polytechnic schools (*SPTU*), whose main "task is, based on broad general and polytechnic knowledge and production training, to prepare students scientifically, technically, practically, physically and psychologically for participation in material production." (ibid.). The law was repealed only in 1991, when the Public Education Law came into force on October 18, 1991.

Today, a special emphasis on vocational education is placed through the adoption in 1999 of the Vocational Education and Training Act. Notably, this legislation has undergone 41 amendments and revisions to date. A separate *Craft Act* is also applied in Bulgaria, and a large part of the regulations on vocational education can be found in the main education law - the Preschool and School Education Act.

Polytechnicism as a principle and model for building the structure of secondary education has two strategic goals (Yanev 1961, p. 49):

The goal for the first stage (grades 5 – 8) is to involve students in accessible types of work and in acquiring initial technical and adapted technological knowledge, information and practical habits, group study of basic operations "to use the most common materials, types of energy, tools of labour".

The goal of the second stage (grades 9 – 12) is to obtain a professionally oriented education in accordance with modern forms of division of labour and the principles of scientific organization of labour. (Ibid., p. 54).

The format of the theoretical classes is two academic hour blocks, in which we have a knowledge test of 20 – 25 min., a presentation of the new learning content of 45 – 55 min., a summary of 10 – 15 min., and an assignment of homework of 3 – 5 min. (Ibid*.,* p. 84)

The process of "training on the job", according to the author, goes through *three stages* (ibid., p.76):

First stage - understanding the essence of the work activities in the specialty, familiarization with the tools, devices and raw materials, as well as basic operations;

The second stage – practical mastery of the steps (operations) that make up the work cycles;

Third stage – systematic improvement of habits and automation of activity.

Yanev also draws several conclusions that sound quite relevant even today when it comes to training in vocational education:

– "The student's general educational knowledge is strengthened in the process of polytechnic training."

– Students' knowledge is based on science. It acquires practical value, strengthening the sense of responsibility and the need to study chemistry, physics and biology to illuminate the processes of practice more quickly.

– "Industrial training enriches and expands students' general educational knowledge."

The main characteristics of polytechnics are:

– Multidisciplinary: Polytechnics emphasize training in various technical and engineering fields, allowing students to develop a wide range of skills.

– Practical training: An important aspect is the practical application of theoretical knowledge, which includes laboratory work, internships, and projects.

– Technology Integration: Polytechnics encourage the use of new technologies in teaching and the development of innovations.

– Preparation for the labour market: The goal is to prepare learners for the real demands of the industry by providing them with skills that are in demand by employers.

Polytechnicism also has its shortcomings, which were analysed and formulated in articles even during its implementation by famous Bulgarian educators, such as G. Khrusanov and T. Georgiev (1960), Sergey Yanev (1961), and others. They were mainly related not to the didactic and methodological framework, but to some of its organizational defects: lack of material resources in all schools where it was implemented, insufficient control over the implementation of practices, fictitious practices, etc.

With the development of society, with the advent of technology and digitalization, the face of education is completely changing. J. Semrad and M. Skrabal emphasize that "As part of the process of modernization of educational content, polytechnic education has become an important factor in dealing with the complex relationship between general and vocational education." (Semrad 2017, p. 58). The modern school is an ideological product of the crisis of postmodernism, and its ideas can be illustrated through several examples. According to M. Peters, "In postmodern education, there is a focus on the perception of ambiguity and complexity, rather than on the search for absolute certainty." (Peters 2000). For D. Flinders, "In postmodern education, the emphasis is on the deconstruction and questioning of traditional narratives and power structures" (Flinders 2008).

Although in a different form, the ideas of polytechnicism are still applied in modern education systems. Although the term "polytechnic" is not used as often, the concept of combining theory with practice remains relevant. Polytechnic education is found today in:

– *The idea of on-the-job training* – large companies such as Siemens, BMW and Bosch have their own educational programs that combine training and work.

– *Project-Based Learning, PBL* – more and more universities and schools are introducing a model in which students learn through practical projects, solving real problems and making connections between different scientific fields.

– *Dual education* – in countries such as Germany, Austria and Switzerland, dual education is highly developed, which combines school education with practice in a real work environment (factories, enterprises, IT companies, etc.). This is a modern version of the polytechnic model.

Similar to *Polytechnic Training*, dual training is characterized by:

1. *Parallel training*: Dual training takes place simultaneously in vocational schools and companies. Students spend part of their time in the classroom and another part in practical training in the workplace.

2. *Partnership between schools and employers*: Training is organized on the basis of a collaboration between educational institutions and employers, which provides the necessary resources and conditions for practical training.

3. *Duration of attendance in training*: Training usually lasts from 1 to 3 years, depending on the speciality and the level of qualification being acquired. For partial professions, the duration can be up to 1 year.

4. *Workplace-Based Learning*: A significant portion of learning occurs in a professional environment, enabling students to acquire job-specific competencies.

In fact, while the concept of polytechnicism was evolving in the Eastern bloc, particularly in the USSR, the idea of STEM education emerged in the West, notably in the USA. One of the Bulgarian scholars contributing to the study of STEM education is D. Kozhuharova and M. Zhelyazkova. In their article "The Essence of STEM Education", they analyse over 30 publications on the origins of STEM and identify three distinct periods in its development: the 1950s, the 1990s, and the early 21st century. The similarity between the two is expressed in:

1. *Interdisciplinarity:* Both educational approaches emphasize the connection of different disciplines. Polytechnics combine scientific and technical knowledge with applied learning, while STEAM adds the arts to the mix to encourage creativity and innovative thinking.

2. *Practical learning*: Polytechnics and STEAM education place great emphasis on the practical application of knowledge. Students engage in projects that require practical skills and real-world problem-solving. This approach prepares students for the real world and their professional careers.

3. *Critical Thinking and Problem Solving*: Both approaches encourage the development of critical thinking and problem-solving skills. They present students with challenging tasks that require analytical thinking and creativity.

4. *Technology and Innovation*: Polytechnics and STEAM education emphasize the use of modern technology and innovation. Students are introduced to new technological trends and learn how to apply them in different contexts.

5. *Social and Empathic Skills*: STEAM, especially through the inclusion of the arts, places an emphasis on social and empathic skills. Polytechnics can also incorporate these aspects through projects that require teamwork and collaboration.

Conclusion

Polytechnic, dual, and STEAM education all share the common goal of developing well-prepared, creative, and adaptable professionals capable of addressing the challenges of the modern world. The primary difference lies in the different time frames and socio-economic conditions in which they were introduced; yet, the core principles remain fundamentally the same. The analysis suggests that before labelling an idea as "new" it is prudent to look back, explore historical records, and determine its previous existence or form, before considering it truly novel and innovative. The evolution of polytechnics through the integration of dual and STEAM education demonstrates that education is continually advancing, in step with technological advancements and the changing conditions of our society.

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