Available online at: https://jurnal-fkip.ut.ac.id/index.php/ijrse/issue/archive
International Journal of Research in STEM Education (IJRSE)
ISSN 2721-2904 (online)
Volume 6 Number 1 (2024): 1-14

STEM in Croatia: Americanization of Education in Decline

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Abstract

This paper critically examines the adaptation of American STEM educational practices within the Croatian education system, assessing their suitability and effectiveness given the significant socio-economic and demographic differences between the two countries. Through comparative analysis, the study juxtaposes the STEM education frameworks of the USA and Croatia, utilizing data from educational policy documents, student performance records, and demographic statistics to explore the transposition of educational models. The findings indicate that the direct transplantation of American STEM educational strategies into the Croatian context has not been entirely successful, due to Croatia's unique industrial landscape and ongoing population decline. The study highlights significant disparities in the effectiveness of STEM education, which are exacerbated by these national differences. The implications of this research are twofold. First, it suggests that countries need to consider their specific industrial and demographic contexts when adopting foreign educational models. Second, the study raises concerns about the sustainability of the Croatian education system's approach to preparing students for future STEM careers. The results call for a reevaluation of policy strategies, suggesting that more localized adaptations of STEM education may be necessary to address the unique challenges faced by countries like Croatia.

Keywords: *STEM education, education, Croatia, Americanization*

INTRODUCTION

The United States of America has held the title of the bastion of democracy and progress since the end of the Second World War. The American Dream, a national ethos or better to say a national myth, came to be an ideal that showed that every "individual small man" can succeed with hard work. Hard work has been and stayed seen mostly as the work in the industry sector of production. Hard work has been almost equalized as the only honest work through various populist political speeches. This Dream represents the idea that freedom, democracy, and capitalism are inseparable and thus positive in every aspect. Any true progress is possible only in that closed system, a system that must spread so well-being would spread too. In reality, the American Dream failed, yet it managed to sustain the image in which it did not fail. Following the falls/fails of other political socio-economic systems in the world, especially at the end of the 1980s, and the effect of globalization as global states and cultures due to technological development become more connected and mutually dependable, the idea of the American Dream spread universally. Globalization became fueled by Americanization, multi-sideway uniformization where the USA has been idealized and imitated. Uncritical acceptance of various American cultural products sometimes enriched, but always deeply changed the receiving country or culture.

Creating an image of a superior society where anyone can succeed if they just work hard enough, necessarily creates a change in shared cultural values. Cultural values withhold the idea of desired expectations. These expectations can be promoted by various acts of popularization or some type of

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DOI: https://doi.org/10.33830/ijrse.v6i1.1637

repressive measures such as limitations of wanted means so the need would be directed to the unwanted, that is the one desired by one in power. In the modern world, the tendency is to use the first or a combination of both methods. Globalization and Americanization influence the cultural development of whole countries, and education is just one of the ways of directing economic development. Humanities and social sciences, as so-called soft sciences, repeatedly have been attacked from the positions of hard sciences as unproductive (in a capitalist sense), and too expensive, while hard sciences have been (self)glorified as only progressive and only necessary in the development of countries, its economies, and citizens as workers. STEM education stands here as an ideal form.

Americanization in this paper is not understood as a product of modern globalization, where these two terms are quite often understood as interdependable; where it represents the spread of American culture, and everything it includes, what could be seen as a positive form of Americanization where personal freedoms, free market, and general liberal values are beneficial for receiver. Americanization is seen in its negative form, where the receiver is trying to imitate the USA models in expectation of having the same results without understanding that different systems are based on different past and existing traditions, and application of something new is not possible without deeper changes. Changes that cannot be done in a short period. This paper examines the influence of Americanization through a specific education type - STEM education and emphasizes of STEM professions, in one Southeastern European country with its own specific sociocultural issues aiming at making its global footprint among the well-developed (dominating) industrial countries.

Since the 1990s idea of a need for education for specific hard sciences - STEM spread from the USA to the rest of the world. STEM is proclaimed as the education for the future, therefore it has been equalized with the future. However, American attention to specific scientific fields fairly predates it, stemming from its 1st Congress. Scientific progress early has been understood as a precondition for national progress and well-being. Since then, the best source of successful, qualified citizens depended on national educational policies and qualified immigrants. Greater emphasis has been put on the areas of, today called, STEM education in wartime; the time of World Wars, the Cold War, and its aftermaths. The Russian launch of the Sputnik satellite in 1957 started the “space race”, resulting in important educational reforms in the USA which within a decade doubled the number of college and university students, and increased interest in technology and space exploration. In early 1990 the situation was similar. In the new global environment of new democratic societies and its now more mobile population, the USA felt that the performance of its students on international tests, such as International Science and Mathematical Olympiads, etc., is lacking so the financing of education in programs dealing with natural science started increasing. Additionally from the perspective of contemporary technological innovations, the USA recognized China as its potential threat in, the so-called, innovation economy. Chinese students also score better at the international student testing in various fields of natural sciences, and Chinese universities produce more successful graduate and doctorate students in the same fields than is the case in the USA. This reflects on industrial development. This need for more STEM professions is an ongoing process, Barack Obama, the 44th American President, made STEM education a priority in education reforms, stressing its importance for the individual and nation’s future. The present president, Joe Biden continued the efforts and even started an initiative to extend STEM into STEMM, where the last M stands for Medical Sciences (Atkinson and Mayo, 2010; Bybee, 2010; Gonzalez and Kuenzi, 2012; Handelsman and Smith, 2016; Stanford, 2022; Stedman, 1994). Research indicates that the perceived knowledge gap in American students compared to their counterparts in other developed nations may not be as extensive as commonly thought, with variations across socio-demographic groups (NYT, 1991). Despite efforts to advance STEM education and align with business and future workforce needs since the 1990s, student

interest in STEM fields has waned. Factors influencing interest are numerous, with personal preferences often being a decisive element in educational and career choices (Bøe et al., 2011).

Research Objective

Based on the conclusion drawn, a pertinent research question could be: "How can Croatia's STEM education system be adapted to reflect both global trends and local socio-economic realities to effectively prepare students for future professions within the national context?"

DEFINITION AND ORIGIN OF STEM

STEM is an acronym that stands for Science, Technology, Engineering, and Mathematics. STEM did not start as STEM, in fact, the first acronym was SMET. SMET was the acronym used by the American National Science Foundation (NSF[1]) with the same meaning, however, the name was changed in 2001 after NSF's Education and Human Resources Division director Judith Ramaley noticed that the pronunciation of SMET sounds a bit like the pronunciation of "smut" (Breiner et al., 2012, p. 4; Sanders, 2009, p. 20). STEM[2] indeed sounded better than SMET/smut[3], and it fitted better the agenda it promoted. STEM represents the core of the educational system, or as it could also be said, it represents the core of the education system of modern capitalist society. It is the education in fields that have, or it is presumed to have, a major role in the ongoing and prospective industrial development thus something that generates production of some kind of valuable goods for the market. Atkinson and Mayo state the need for quality STEM education more directly, and a bit more xenophobically: "[...] we need to recognize that for an innovation economy, we don't need people who, despite being labeled "STEM," have skills or interests that fail to match industry needs. Such individuals are already part of the reason we have so many STEM jobs filled by non-U.S. citizens." (2010, p. 13). As it is noticeable the need for STEM education is to satisfy the need of the industry based on the STEM-educated workforce, creating suitable workers within the existing labor market, thus eliminating any "unnecessary" expenditure for the work permits of non-citizens and their other needs (documentation translation and control, retraining, linguistical assistance, etc.). The emphasis is on the needs of the industry, the forecasts of future technological developments, and economic growth, without individual aptitude and an overview of national resources. This makes a STEM education a cogwheel of the modern neo-capitalist system.

STEM is not a word that is intended to be used individually, as is often the case in popular public informing and laic speech, it is a combination of two words, of which the second one is quite often excluded, and yet it is the one that it gives the full meaning to the acronym. The second word is "education". STEM education stresses the importance of educational activity in the creation of a

[1] NSF is an independent agency of the United States government that supports all non-medical fields of research. Founded in 1950, with the aim to promote the progress of science, national well-being, and defense, today is responsible for around 25% of financial support on a federal level to colleges and universities for their basic research in all areas of science except for medical research (NSF, n.d.).

[2] Stem is according to the Merriam-Webster dictionary (n.d.-2) a noun with multiple but closely related meanings; the main trunk of a plant, the main upright member at the bow of a ship, or in ancestry it is a fundamental line from which others have risen.

[3] Smut is according to the Merriam-Webster dictionary (n.d.-1) a noun with multiple meanings; a matter that soils, fungus-infected plant disease, and obscene word. In short, it represents a filthy state, something that is dirty.

workforce for the STEM labor market. This means that a pedagogical activity has high importance in this process, even though most often it is ignored, predominantly in media reports and private sector complaints on the need for a more STEM-educated workforce but not educators of that workforce. A professional from a STEM field may be excellent in his/her job, but that does not mean he/she is excellent in the transfer of knowledge needed for that job and a wider field of expertise in that specific field. Without improvement in teaching specializations in STEM areas, STEM will forever stay just a set of try-and-hope-to-succeed attempts, political populism, and the media-spread critiques of existing education systems.

STEM education refers to both formal and informal education at all education levels (Gonzalez and Kuenzi, 2012, p. 1). Introduction of STEM education and STEM-orientated activities can be made by: "[...] a top-down curricula reform emphasizing STEM subjects and digital literacy, or a bottom-up approach targeting key segments of the population in cooperation with civil society and private sector." (CEP, 2021, p. 37). This means that certain activities and programs can start as early as preschool education at childcare institutions, following further through all levels of education. Some researchers consider that STEM education refers to the education in primary and secondary schools, that is a pre-college education (Bybee, 2010: p. 996). Additionally, informal education can be made through various activities, for example, in libraries, or some non-governmental associations, and their voluntary programs. A general idea of propagated STEM education is that STEM-educated pupils become STEM-literate citizens ready for the 21st century (Bybee, 2010, p. 996) because expertise in areas STEM education covers is considered to be of critical importance for the 21st-century economy and thus people's place in the labor market (Gonzalez and Kuenzi, 2012, p. 1). However, if observed objectively, this kind of social engineering that starts in early childhood with the aim of creating a workforce wanted by the private sector, and economic aspirations of the country's government seems as something more common for dictatorships than to the modern democratic environment.

Even though the understanding of the parts that make a STEM acronym is self-evident in the Anglosphere, in other parts of the world it is not as clear regardless of its recent popular usage. S-cience covers natural sciences such as biology, chemistry, geology, physics… T-echnology covers a narrower field of technical/technological sciences including computer sciences, logistics, etc. E-ngineering covers disciplines such as civic engineering, electrical engineering, architectural engineering, and M-athematics is the only discipline that is expressed individually because it is considered that it represents some basis for other fields.

For people who do not belong to the Anglosphere, it is noticeable an overlapping of categories of these fields. The term "science" is understood as a superior term to other ones, and it does not have a dual understanding as in Anglosphere. Modern understanding of the term science today replaced what the traditional understanding of philosophy once was. Philosophy was the science of sciences. The origin of all modern European understanding of the world started with Ancient Greek philosophers. A philosopher was a thinker, educator, innovator, engineer, etc. A major part of Ancient Greek philosophy, Aristotle's natural philosophy (*Physics or Philosophia naturalis*, *Parva Naturalia*, *Meteorologica*, *Historia Animalium*, etc.) that kept its influence up to medieval times when first universities were founded and disciplines became prominent and separately researched, proves its importance. In these universities until the 18th century and in some even longer faculties and departments dealing with what is called today natural sciences, called their specializations to be part of natural philosophies (Blair, 2008: pp. 363-406).

Modern science was born out of philosophy, and finally replaced its terminological superiority, making it just one of the fields of its own subdivision of humanities. At the final educational level at the

end of tertiary education, doctoral studies still end with the awarding of the title of Doctor of Philosophy (Ph.D.), regardless of which field of modern science it is awarded[4]. That is the final remnant of its historical importance. According to the modern understanding of science, its further division is into fields, which divide into areas, and those finally divide into branches. For example, mathematics is just one of the branches of the natural sciences, which are an area of general sciences. Looking at it top-down, modern science is understood as divided into a couple of fields: natural sciences, human sciences (more commonly known as humanities), social sciences, medical sciences, technical sciences, and art, where each of them further divides into their own retrospective areas, which further divide into branches. American (or better to say Anglophone) use of science, exactly use of a homonym of science, is used both as a superior term for all sciences, and more often as a general term for natural sciences and single school subject of interdisciplinary topics of natural sciences. That kind of understanding of science is limiting and creates a prejudice that a scientist is only someone working in a white coat in the laboratory, while all other academically educated experts are not. This creates multiple interpretations even within the USA and creates issues in the application of paradigms such as STEM education out of its borders.

In Croatia, the division of sciences is legally described by the *Ordinance on scientific and art fields, areas, and branches*[5], and it follows the broader European tradition of understanding of division of modern understanding of science. The main division is as follows, into nine areas: natural sciences; technical sciences; biomedicine and health sciences; biotechnical sciences; social sciences; humanities; art; interdisciplinary areas of science, and interdisciplinary areas of art. Simplistic application of STEM education paradigm is impossible, however, it gained popularity as another form of self-imposed Americanization of the education system. The question remains will it succeed or it will have the (miss)fortune of other imitations of the American education system?[6]

AMERICAN EDUCATION SYSTEM

The American education system is divided into three educational levels, as is the case with most of the educational systems of organized countries in the world. Primary and secondary education systems are known as K12 education, as they start in kindergarten (preschool education), followed by 1st grade, and end in 12th grade. This covers the children (usually) of age 5-6 and ends at age 17-19. However, kindergarten is not a compulsory part of (preschool) education. According to National Center for Education Statistics information for 2020, out of 50 states - 21 states require its districts to offer a full-day kindergarten program, 25 require it for a half-day kindergarten program, but only 20 require kindergarten attendance (2020). Kindergarten serves as a preparatory year for obtaining basic literacy, numerical, and social skills before the first grade of primary school. After that, the child starts its 12 years of compulsory education at primary and secondary education levels. Primary schools offer primary education in 8 grades (some jurisdictions offer, a so-called, middle school that covers the 7-8 grade and serves as a transition towards high school), and high schools offer

[4] Even though a minor part of universities in Anglophone countries award titles that are more specific and less traditional, such as f.ex. doctor of education (Ed.D.), doctor of theology (Th.D.), doctor of science (D.Sc.), doctor of engineering (D.Eng.), doctor of business administration (D.B.A.), etc.

[5] hrv. *Pravilnik o znanstvenim i umjetničkim poljima, područjima i granama*.

[6] As it was an attempt to introduce fees for studies in public universities (state-funded) in 2009., which failed after monthly student protests and occupation of faculties at various Croatian universities. The main motto of the student protesters demanding free education equal for everyone was "Znanje nije roba/Knowledge is not a merchandise".

education in the final 4 grades. Pupils are graded on the A-F scale (A, B, C, D, F; where A is the best grade, and F stands for fail), and from 6th grade of primary school, those grades are entered into their official transcripts. In the last year of high school, Pupils take the SAT - a standardized, time-limited test that measures students' literacy, numeracy, and writing skills and serves with high school grade point average (GPA) in college and university admission process, for those who are planning to continue their education on tertiary education level. Another standardized test that serves for admission to colleges and universities is ACT. This testing is compulsory for graduation from high school in 25 states; however, starting tertiary education without it is almost impossible. American pupils in K-12 education have relatively general education, compared to some other countries, and every high school graduate, depending on their success, has the right to apply for university studies (where they for the first time select specialization). Those who are not continuing their education at the tertiary level, are entering the labor market or continuing education in post-secondary vocational schools.

CROATIAN EDUCATION SYSTEM

Even though similar to the American, the Croatian education system is much more limiting for a child, and it forces it to select (or its parents) its lifepath much earlier in life. Children start their compulsory education at age 6-7 and end it at age 18-19. Formal primary and secondary education last 11 or 12 years, dependingly. Preschool education (hrv. mala škola) that correlates with American kindergarten is compulsory, lasts a year, and after it children start their first grade in primary school. The grading system is consistent on all three levels of the education system in Croatia, grades are on a 1-5 scale (1, 2, 3, 4, 5; where 1 is a fail, and 5 is the best grade). Primary school lasts 8 years and is divided into the first 4 years of lower grades of primary school, and 4 years of upper grades of primary school. The first 4 grades of primary school pupils have one teacher instructing them on all subjects, while in the last 4 years, pupils have different teachers specialized in their own field for every specific subject. After finishing 8th grade of primary school, at the age of 14, based on grade point average and grade point average of specific subjects (with “minor” influence of parental wishes, and own inclinations) pupils apply for the selected school of secondary education. Croatian secondary education is far more diverse than many education systems in the world, and as such it creates life limitations far earlier than children are even able to understand it. There are three basic types of high school education: gymnasiums (hrv. gimnazija), vocational (hrv. strukovna škola), and art schools (hrv. umjetnička škola). They offer 3 and 4-year-long programs of high school education. 3-year long high school programs are offered exclusively by vocational schools, where pupils are selecting programs that will provide them with specific professional qualifications after graduation (for example; butcher, waiter, cook, plumber, electrician, mechanic, professional driver, cashier-seller, beautician, hairdresser, etc.), and they do not have an option to continue their education at the tertiary level. 4-year-long programs of high school education are offered by technical schools (hrv. tehnička škola), art schools, and gymnasiums. Pupils in technical schools are selecting programs (f.ex. agricultural technician, forestry technician, geodesy technician, logistics technician, veterinary technician, chemistry technician, ecology technician, mechanical engineering technician, computer technician, etc.) which will provide them with specific qualifications after graduation. High school students finishing 3-year-long and 4-year-long programs in vocational schools are obliged besides their regular school activities, to have practical hours in private or public companies. 4-year-long education in gymnasiums differs also mutually depending on the type of gymnasium and school curriculum (general gymnasium, sports gymnasium, classical gymnasium, linguistic gymnasium, natural sciences gymnasium, etc.). An obligatory part of finalizing education in a gymnasium is a standardized test of state matura (hrv. državna matura) from selected subjects. Based on the results of state matura and grade point averages students are applying for admission to faculties and universities for a continuation of their education at the tertiary level.

Looking at the Croatian division of school types within its secondary education system it is noticeable that STEM is already the main part of the education of the majority of vocational schools (and some

gymnasiums), however, STEM education has multiple obstacles that block the initial expectations and purpose of STEM education as understood globally. Secondary school students who are studying in technical schools are finishing their education without a straightforward option to start their university education, therefore the idea of having a high-paid STEM profession of university-educated people in "economies of the future" is lacking in its implementation. In fact, it could be said that the expectations from them are the same as from the students finishing vocational school - to enter the labor market right after graduation. The state matura was introduced on a national level in 2010 as a replacement for school matura. The general idea was to have standardized testing supervised by the National Center for External Evaluation of Education. However, it is obligatory only for gymnasiums, while other schools have school matura. Pupils from vocational schools (that is technical, 4-years-long programs) have an option, in addition to their education, to take the exam of state matura but it is quite often too much of obligations added to their regular requirements of studies. State matura created additional class divisions within the society where some are expected to work right away after graduating high school, and others to continue their education at the university level, thus later in life securing highly paid positions. There are additional discrepancies in the system of standardized state matura. For example, someone who finished a sports gymnasium has the right to apply for university studies (in any field), but someone who graduated high school in technical programs, such as chemistry technicians, cannot. This directly blocks the continuation of higher STEM education for one part of high school pupils, while it gives it to others who are relatively new to it. It seems that 21st-century Croatian education actually imitates the expectations of education of the Middle Ages, where children of university-educated (white-collar workers) also follow their parents' steps, and children of blue-collar workers theirs, becoming blue-collar workers, which is just confirmed in the "science capital" of family background. It seems that the whole life of an average Croatian pupil is decided at the age of 14. If STEM professions, as are promoted globally, are taken into consideration, it seems that regardless of national activities in Croatia of the application of various STEM education in the educational system, they are more understood as the need to create more plumbers than engineers, which definitely is not a profession of the future.

STEM IN CROATIA

STEM education in Croatia represents an imitation attempt of well-developed countries, with much bigger populations, economies, and most importantly, overall different histories. Global popularization of the need for STEM education can without any issue be called the last form of Americanization. In this case, the negative kind of Americanization in which countries themselves introduce American projects, hoping that it will put them on the level of American industrial development, thus making them competitive on the global market while ignoring all the other home factors that are the reason for their actual state. When the overview of the Croatian economy and the possibilities is viewed objectively, it is noticeable that the main part of the national economy depends on the service sector (predominantly tourism, and export), and that industrial production is limited or in decline. Developments in ICT are expected to be of great importance in the future growth of the economy, so Croatia as a member of a group of few other countries (Bulgaria, Czech Republic, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia) of Three Seas Region, all who had new high development rate in the field, organized in various projects of cooperation with intention of better connectivity, the attraction of domestic and foreign investments. The mentioned countries have achieved as good or better development in the field as much more developed Western countries, however, they still need to catch up with them (CEP, 2021, p. 20).

STEM in Croatian schools, childcare institutions, and libraries besides "a top-down curricula reform emphasizing STEM subjects and digital literacy" (CEP, 2021, p. 37) has been using "a bottom-up approach targeting key segments of the population in cooperation with civil society and private sector."

(CEP, 2021, p. 37) to promote, develop and implement STEM education. In fact, the major part in the introduction of STEM has been made by various civil society associations and the private sector that organized various activities or donated equipment to public institutions. One of those civil society associations is the Institute for Youth Development and Innovativity whose Croatian makers project holds the status of the largest non-governmental STEM education program in the European Union (CEP, 2021, p. 37; IRIM, n.d.). The intention of this, and other projects the association conducts, is to develop STEM competencies in children, providing them with equipment, and activities, educating teachers, etc. (IRIM, n.d.). The activities provided by this association were so successful that they started offering them in Croatia's neighborhood countries, and farther. However, regarding all the positive sides this kind of activities provide in STEM education, it raises a serious question regarding the function of the formal education system if teachers have to be additionally instructed by people out of the scientific community, and that school equipment for the modern age depends on donations (some schools are using over 30 years old equipment). As in the USA, to improve STEM education it is firstly necessary to improve the learning environment (Atkinson and Mayo, 2010, p. 63), but if the education environment is dependent on donations, then the function of the Ministry of Science and Education is seriously questioned.

From formal educational and research institutions it is necessary to mention JOBSTEM project, conducted in cooperation of Croatian and international researchers, whose aim was to conduct research on younger pupils in primary schools, record their understanding of STEM fields, interest in it, and conditions that affect mentioned, as well as organizing various activities for gifted pupils in STEM area (JOBSTEM, n.d.).

A top-down approach to the popularization of STEM has been done by the Ministry of Science and Education which since 2015 in its various reforms, public support, and overview of good international and national practice, national financing, and EU grants applications. Ministry of Science and Education provides scholarships, according to specific regulations, to university students in study programs in:

"[...] biotechnical, technical, biomedical and natural sciences, study programs leading to the academic or professional title of bachelor's degree in informatics, business informatics, information sciences, information sciences and information technology, master's degree in informatics, information sciences, information sciences and information technology and professional specialist degree in business information systems, and STEM teaching study programs for which a permit has been issued to carry out a study program for the teaching major, and study programs for the teaching major in informatics that lead to the academic title of Master of Informatics Education." (MZO, n.d.).

This scholarship provides financial support for the students who are successful in their studies in the mentioned programs; however, not every student receives it.

Regardless of media popularization of STEM education and STEM professions; involvement of civic society associations in the popularization of STEM and their cooperation with childcare institutions, primary and secondary schools, and libraries; and Ministry of Education involvement, etc. on the tertiary level of education there has been noted a vast disproportion of offered study programs and applied, and enrolled students, especially on universities of applied sciences. In 2023 the number of applicants to universities of applied sciences was ½ of the offered study places, while in universities it was ⅔. Not every applicant satisfied the enrollment requirement or decided to enroll. In some programs the has not been even a single enrolled student, for example, the Faculty of Metallurgy in Sisak of the University of Zagreb had 13 applicants out of which not was enrolled in the study of Metallurgy and its specializations Metallurgical Engineering and Industrial Ecology (enrollment rate was 58 students), also no students on the part-time study of Foundry Technology; University of Zagreb's Faculty of Textile Technology study of

Textile Technology and Engineering with specialization in Industrial Textile and Clothing Design had no enrolled students; Universities of Applied Sciences Marko Marulić in Knin had no enrolled students on professional study Karst Agriculture with specializations in Plant Production, and Animal Husbandry; some other university and professional studies such as Environment Engineering, Ecology of the Sea, Civic Engineering, Naval Architecture on some other universities and universities of applied sciences also had no enrolled students (Lilek, 2023). Mentioned STEM study programs and professions are not only significant marks of (un)popularity of specific programs in specific areas, but they also show that existing enrollment numbers and even whole programs are based on wrong projections of the needs. No further investment in the field, popularization, or technical equipment could change the application and enrollment rates if there is no interest. Interest is not based only on the results of the popularization of a given area, but on an understanding of the possibilities of future employment in the same.

Authors of Refueling the U.S. Innovation Economy: Fresh Approaches to Science, Technology, Engineering and Mathematics (STEM) Education passively-aggressively complain about not enough recognition of the importance of STEM in Washington political circles, as it is the case with Chinese who consider STEM graduates and STEM contribution to society to be of higher importance than of those graduating in humanities and social sciences: "On what basis is government to say that electrical engineering degrees are more important than French literature degrees or even law degrees?" (Atkinson and Mayo, 2010, p. 12). The same situation is noticeable in Croatian media; however, those are just populist quasi-arguments that serve just for the pollution of the public image of the issues in the education system and its correlations with the employment sector.

PUPILS ON/IN STEM AREAS IN CROATIA

Research conducted in higher grades of primary school showed that there are generally no differences among male or female pupils in their inclinations toward STEM areas, they have generally positive perceptions of science and scientists (although sometimes stereotypical), but the most positive perception comes from more successful pupils, and those who are from academically educated families (Burušić, 2018). However, it is necessary to remind that after finishing primary school, pupils have to decide which program, and which type of secondary education they will continue with. Even though there is more research that needs to be done on the causes of selecting specific programs, the emphasis is on one's grades and parental direction. An aptitude for STEM can be ignored due to bad grades in applications for high school, or a specific STEM program can be selected for the same reason (inability to apply for a desired program outside of the STEM field). Decision (or better to say grades) at the end of primary school affects all further life of a person and options for possible university studies.

Research conducted in secondary schools showed a disproportion in STEM interests among the genders, male pupils were dominant in all STEM fields, except in the field of Biology. The role of academically educated parents (where STEM-educated father is shown to have a bigger influence) is again shown to be one of the major factors in pupils' inclinations and predispositions (Šimunović et al., 2020). However, considering how secondary education in Croatia is quite diverse, and that STEM professions could be understood selectively among both gymnasium and vocational school programs, that is, education programs in STEM fields are already programs in which pupils are receiving education, one must understand that inclinations towards STEM areas are relatively pointless for research. It is expected that pupils educated for example in programs for Chemistry Technicians will have more inclinations for STEM than other pupils educated as Tourism and Hotel Management Technicians. The gender gap in STEM programs in vocational schools is still quite big with male pupils dominating.

The coronavirus pandemic 2019-2022 affected education where subjects, and programs that are considered to be under the STEM umbrella (and had a higher level of practical work in the form of conducting

experiments) were more affected by the transition to online education. Research conducted by Sambolek and Vadlja Rešetar (2021) during the pandemic, on secondary school pupils' satisfaction with online classes of subjects Mathematics, Biology, Physics, and Chemistry showed that students were generally satisfied by the way it was done, however, that online teaching was more difficult and harder to follow.

It is noticeable that pupils having academically educated parents, have higher interests and achieve better success in education; have better interests, predispositions, and success in STEM fields, than pupils who do not have academically educated parents, and are already achieving weaker success in education (Burušić, 2018; Šimunović et al., 2020). Researchers call it "science capital" (Archer, Dewitt, and Willis, 2014, cited in Šimunović et al., 2018). This science capital greatly affects pupils' progress through education. Parental mental and financial support, their establishment in the private or public sector on higher and better-paid positions, necessarily gives better-starting positions to those pupils than to others who do not have that kind of background. It is quite normal to expect that children of university-educated parents also continue and finish university studies. Social conditioning is quite effective, in both groups of pupils and their views on the future, and their own place in the world.

ISSUES OF CROATIA, AND ITS STEM FUTURE

Croatia faces multiple problems, out of which two are most important as they directly reflect on the issue of education. The first problem is the economy, which is marked by the decline of industrial development; and the second is population decline. The Croatian economy, as mentioned, is based on the service sector which provides for ⅔ of gross domestic product, where income from tourism amounts to around 20% of the GDP (LZMK and MVEP, 2023). For example, in 2022 it was 19.5% (MINT, 2023, p. 43), and it is expected to continue to grow unless there is no pandemic or other unforeseen circumstances in the future. Regarding the dependency on tourism income, Croatia is more dependable on it than its Mediterranean rival countries with their tourist destinations (Lider, 2022). This just shows that the type of tourism Croatia has is a conventional one with inclinations towards over-tourism, instead of a well-developed sustainable tourism. As expected, vocational education has a large number of education programs for the vocations in service sectors that provide employment to its graduates, and even those who do not hold the expected vocation.

Population censuses, since Croatia's independence in 1991, continuously show a population decline. Even though the reasons for the initial decline during the War of Independence and its aftermath could be explained by the direct war activities, decades after the population is still in decline. It is much harder to provide an explanation for the causes of population decline in peaceful times two decades after the war, economic revival, and accession to NATO and the EU. According to the census in 1991, Croatia had a population of 4,784,265 inhabitants. The census in 2011, the last census before Croatia became a European Union member state in 2013 showed that population decline was ongoing, with a population of 4,284,889 inhabitants. The last census in 2021 showed shocking results of a population decline to 3,871,833 inhabitants (DZS, n.d.). Even though Croatia has a higher death rate than the birth rate, the major part of the decline of population is emigration. Immigration to Croatia is small, in 2022 only 57,972 people immigrated. However, the ethnic structure of new immigrants is something quite different than the old one. New immigration shows different patterns instead of expected traditional immigrant ethnicities; in 2022 immigrated 11,121 Ukrainian war refugees, 11,874 immigrant workers from Asian countries (from India, Nepal, Philippines, etc.), and 675 immigrants from African countries (Milovan, 2023a). Seeing Asian workers delivering food by scooters or bicycles, while working for one of the multinational online food ordering and delivery companies became quite ordinary. However, it signifies one thing that is not mentioned in political life; those third-country nationals obtained working visas for

positions that require no formal education, and no skills except a driving licence. It shows that Croatia is losing qualified workers/citizens, and receiving unqualified workers. This type of immigrants will not be able to take part in Croatia's idea of a STEM-oriented future, but to petrify its position as a service-oriented country.

Population decline necessarily reflects on the education system. In the period from 2013 to 2021 Croatia had to close 105 branch primary schools as they had no or not enough enrolled students, (Findak et al., 2021), yet it is not surprising at all (contrary to some news titles and politicians' sudden realizations), that emigration of educated and skilled workforce and their families inevitably has that effect on student numbers for the last decades (Vojković, 2023). As Vojković puts emphasis: "Demographic a disaster is a logical consequence of crony, instead of market capitalism; corrupt politics that selects suitable, and rent-based economy that help only some." (2023).

The number of pupils in schools means that in the future there will be less "native workforce" and thus less taxation which serves, partially, for the payment of pensions. Even though the number of retired persons now surpasses the number of the active workforce, the number will be even higher in the future. Without new incomes, the pension system will not only not be sustainable to be at the same rate, but it will also collapse.

Looking at the data from the census it is easy to make some presumptions on the future needs of the Croatian education system. It seems that STEM education will have to be replaced by more education from the field of social sciences. Children of new immigrants will have to be offered (and developed) adequate language and integration programs. Those programs are not something new for the Croatian education system, however, they were never simultaneously offered to higher numbers of different ethnic, linguistic, and cultural groups in such a short period. Only after linguistic and integrational issues have been resolved, can one talk about further directed education. One cannot learn something if one does not understand the language and socio-cultural conditions of the new country of living.

Looking at the data published by the national Croatian Employment Service , this agency has fewer registered unemployed persons in 2023 than in 2022 according to a monthly comparison, furthermore, another published graph provides data that the majority of unemployed left the list of unemployed persons due to employment (HZZ, 2023). However, crude statistics do not correlate with the actual state, as seen in daily newspaper reports, TV news, personal stories (oral, shared on social networks, or foreign immigration and employment services reports for Croatian citizens), and sociological research. Or better to say, statistics itself is suitable for various interpretations that are mostly used for political populist purposes. Numbers are continuously lower for two reasons, depopulation of the country (emigration of educated and skilled workforce together with their families), and second reason is removal from the unemployed list registered by the Croatian Employment Service due to various reasons.

If the list of most sought job positions is observed, where most required are sellers, waiters, cleaners, nurses, caregivers, preschool educators, drivers, and warehouse workers (Milovan, 2023b) it can be clearly seen, with the exclusion of preschool educators, that most of the required positions are vocational positions. Same positions for which in most countries of the world (sellers, waiters, cleaners, caregivers, warehouse workers) education does not exist, as it is not required except for short training as an introduction to the working process. Further investment in STEM education is an investment in continuous "brain drain". It is hard to expect that a STEM-educated workforce, especially that university-educated will stay in a place where there are no possibilities of employment in the field (concerning the state of industrial decline of Croatia), nor that various programmers and informatics experts will want to stay in the country with high cost of life and lower salaries than they would get abroad. It cannot be said

that STEM education is not needed, but it must be said that employment options after obtaining a profession or degree are limited, and without serious structural reforms, the promotion of STEM education is just a form of Americanization doomed to fail.

AS DISCUSSION

STEM education in Croatia has been recognized on a national level as one of the necessary fields of education for the professions of the future. However, except for some additions to the curriculums, and the provision of scholarships for a certain amount of university students, not much has been done by the state, and the Ministry of Science and Education at the top-down institutional level. On the other hand, a lot of investment has been made from the non-governmental sector, predominately by associations of civil society and private investors. The high role of involvement of later mentioned sector in STEM education questions the quality of the education system as such, and its aims in educating pupils for the high-paid STEM professions of the future. STEM is seen as a path of salvation for the economy, however, with the continuous depopulation of the country, and high dependency on the service sector it is questionable whether would there be any benefits for STEM professionals or it would be education for future emigration. If Croatian and American education systems are taken for comparison, the difference is enormous, yet the ruling presumption is that the Americanized idea of STEM education would be applicable. The American education system has a general form of education for all pupils in K-12, in Croatia's case it ends much sooner, in what could be called K-8, after which a large number of pupils continue secondary education in vocational schools whose programs could be defined as STEM professions. The question is also why STEM is aggressively promoted if the existing education system already holds well-developed subjects, much better specialized than those taught in the USA (and other Anglophone countries). For example, American teachers teaching Science have basic knowledge of various fields of natural sciences, while an average Croatian teacher teaching Biology, Chemistry, Physics, etc. must have a master's degree in their respective field together with pedagogical qualifications, and thus are much more qualified than American teachers. Croatia can think of STEM education as its American Dream however with the ongoing situation in the country, population decline, decline of industry, and focus on the service sector it does not seem like a bright future for the country and its economy.

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