STE(A)M: Not only education but also a lifestyle

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Abstract. If science can define meanings and measure results, art can express them and give a step forward to refreshment and innovation. The artist-scientist archetype started from Archimedes going to Nikolai Tesla, in about the inventor, the seeker, the dreamer, and the thinker, both as new scientist and artist. A growing number of schools are incorporating teaching methods that are more aligned to STEAM education (Science, Technology, Engineering, Arts and Mathematics) since it has become, almost very clear and concrete, that art's education makes learning more fun and keeps everyone involved even more engaged. As exploring new possibilities, to lead innovation in the classroom and promote leadership at all levels, encourage teachers and principals, make the school and the whole system a dynamic one. The core value is that the need for STEAM education is critical, especially because there will be related jobs ready to be filled as soon as possible. This job is about to show, when and how can a STEAM educational concept can be delivered in a system that seems to have been destroyed from its old mistakes and can give a real boost to a new oriented public school, in the best possible integrated educational system for preparing students for the university and beyond. Primary inquiry, dialogue, and critical thinking seem to lead the way for a better life in the school environment and real-life society.

1. Introduction

STEAM can combine all the subjects in an interdisciplinary way as well as to the full range of the rapidly changing business and professional world. It is a life-long career and life-readiness way of educating and being educated, learning and continuing to learn, and results adaptable to our rapidly changing global world we all breathe and live in.

The STEAM structure explains how all the divisions of education, in all levels, and life work together; in real-life conditions, can be merged. Therefore, it offers a formal place in the STEM structure for the Language Arts, Social Studies, and the purposeful integration of the exploratory subjects including the Arts, Music, and Physical Education divisions of public education mostly, but not exclusively.

2. Background

Through a literature search, it can be found that the first STEM education translation, "The STEM Project Student Research Handbook" was published in 2013. Since then, Zhao Zhongjian's team has translated and published many related works, such as "The Integration of Engineering and Science in the Classroom", "Design, Production, and Games: Cultivating the Next Generation of STEM Innovators", and "Project-Based STEM Learning: A Way to Integrate Science, Technology, Engineering, and Mathematics" in 2015. He is also responsible for the selection of the "STEM Education Policy Progress in the United States".

Socrates and Aristotle are credited with the concept that the 'pursuit of knowledge is the highest good and that this is the basis of education [1]. This is still and will continue to be, the foundational concept of modern research universities.

Comenius was a contemporary of Descartes who stated that 'education is a preparation for life itself' [1]. This aspect of things further opened the door for exploring all means for acquiring and searching for the core value of pure knowledge. By stating that, life itself was a study in education, he formally tied that idea to the development of student-directed and hands-on, and practical learning methods. Mentioning that 'observation precedes analysis' [1], he meant that it also precedes the rules of analysis and meanwhile critical thinking.

The 'New Method' of education was officially created in the 13th Century [1]. It is the basic axis of the modern educational structure still followed in schools of today. Its basis is the concept that schools should be democratic in nature versus the previously used authoritarian models [1]. This, let's say option, marked a significant shift from the concept of content-focused curricula to the transition of promoting a structure of life-long learning.

People's daily behaviors are strongly challenged by information explosion and fissile brain growth the deeper digital technology and the higher degree of integration brought about by the development of the New World have also triggered the transformation of the social industry

structure. Through Klaus Schwab's research on adapting to the talents of the future society, it can be seen that by 2020, people with complex problem-solving skills, excellent social skills, and integrated system skills will have more room and opportunity for development, as much as sustainable can be.

The concept of STEAM can help make good education even better. Its framework, like steam itself, can fit anywhere and take innumerable shapes and forms, and, if used purposefully, can be a very powerful and enjoyable tool for teaching and learning any level of any topic. It delivers high-quality team-based education to all students. Preparing children for a growing variety of careers is important to advance the global society and its economies. Careers past, current and potential are organized to be taught with STEAM [11], [12], [14], [15].

Students are taught to evaluate needs, wants and opportunities to be informed users, responders, and innovators. It prepares students to be life-long learners in pursuit of college, skilled trade programs, potential yet unknown career paths, and well-balanced lives. STEAM is a whole-learner, community-involved, and influenced learning environment. It has a living-curriculum structure that is representative of the surrounding culture and aware and tolerant of all types of diversity and perspectives.

It is found that the existing STEAM educational institutions generally have the following problems: a lack of team composition, difficulty in independent research and development, single course content, and insufficient validation of course effectiveness [16]-[19].

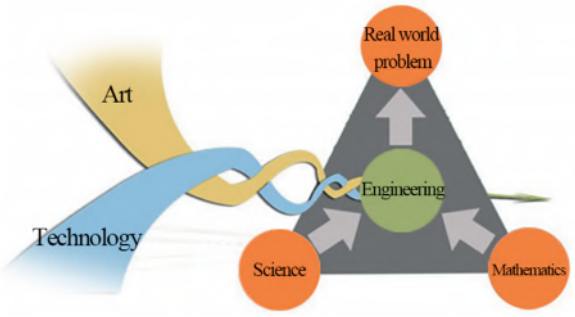


Fig. 1. In STEAM education these relationships should exist between the various disciplines.

3. STEAM Utilization

According to the OECD 21st Century Student Core Literacy Training System and the analysis of the European Union's (EU) lifelong learning eight literacies (use native language communication, use foreign language communication, mathematics literacy, basic scientific and technical literacy, digital literacy, learning ability, social and citizen literacy, self-awareness and entrepreneurial spirit, cultural cognition, and expression), this coincides with the STEAM concept.

As far as the history of its origin, when the argument of discipline-based vs integrative education has been addressed, there has been disagreement. There is no argument that there are connections between the disciplines, but there is in what balance of content of each discipline to teach so as not to lose the uniqueness of the silos [2]. Both types of cross-curricular studies can be valuable, and reality-based. They came up with three distinctions of classification for disciplines being taught together: Coordination, Collaboration, Integration. Coordination and Collaboration are both discipline-based [2]. It is promoted that multiple methods are needed for comprehension of applications across the disciplines [3]. This calls for a structure where individual disciplines can still dominate their realms, but also where there is a constructive time where interdisciplinary studies can be addressed to promote the transference of knowledge.

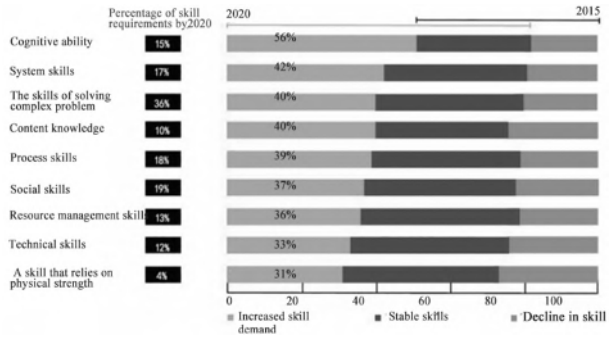


Fig. 2. Statistical analysis of 2020 skills needs.

The most successful institutions of purposefully holistic education include Montesorri and Waldorf. Maria Montessori attributed holistic learning theories to young children and said they needed to have a 'prior interest in the whole; so that they can make sense of individual facts'. Her educational system is one of the most successful systems of 'holistic' education established. It was based on fully integrated curricula, delivery, and assessment methods. Waldorf Education is based on Rudolph Steiner's Anthroposophy theory. The goal is to help produce a person 'who is knowledgeable about the world, human history and culture, who has many varied practical and artistic abilities, who feels a deep reverence for and communion with the natural world, and who can act with initiative and in freedom in the face of economic and political pressure'. A common misconception in our time is that education is merely the transfer of information. From the Waldorf point of view, true education also involves the awakening of capacities – the ability to think clearly and critically, to empathetically experience and understand phenomena in the world. Since these two structures of education have proven to develop functional and universally literate students who have gone on to all areas of post-secondary educational success, they are models of success for integrative education.

Concerning the themes commonly used, it has to be mentioned that STEAM Education is how ALL subjects and people are recognized and can contribute. All effort is encouraged. It is hoped to be a factor in diminishing the drop-out, unemployment, and poverty rates, having to teach to the test instead of the individual, and the disproportionate percentage of women and minorities in leadership positions. Many programs choose to revolve

their STEAM curriculum framework around themes such as:

1. Power & Energy
2. Elements & Processes
3. Life & Movement
4. Transportation
5. Communication
6. Music
7. Inventions

In the 1950s, Snow argued for a rapprochement of the cultures of science and the arts. Today, there is a wellspring of opinion that combining science and the arts in the form of STEAM education is essential for producing a creative, scientifically literate, and ethically astute citizenry and workforce for the 21st century [4, 5]. Already, the US, Korea, and China have begun producing STEAM curricula for their respective nations [6]. Recognizing their limitations in developing students' higher-order abilities, visionary science educators are teaming up with their colleagues in the art learning areas to design innovative interdisciplinary STEAM curricula and teaching approaches. Though naturally, tango needs two, at least, this is a dance that needs more to participate and enjoy. Regarding communities STEAM system, promotes a structure of community and business partnerships with schools. Programs that are well-supported by their communities have a record of higher engagement among educators and all levels and types of students and families for better overall program sustainability. Adding in ecological and cultural sustainability, including rotating displays in the common areas of the schools and having community meetings and program information nights. Educators report parent engagement and donations are increasing [21]-[26], [28].

STEAM asks students to evaluate local to a global career, hobby, and life opportunities and developments in historical, current, and potential contexts. Students are challenged to learn and apply the breadth and depth of content and skillsets across the disciplines through reality-based projects using up-to-date research from the fields. Students are asked to perpetually evaluate their points of interest, experiences, and talents with ongoing portfolio development, which becomes useful for applying to extra-curricular and post-graduation pursuits.

Fig. 3. STEAM figures.

STEAM Educators report feeling rejuvenated by richer living work environments. They can use more diversification of teaching methods and be more of a facilitator to learners. It empowers educators to meet the guidelines in a variety of unique and engaging ways and to meaningfully cross-reference concepts and vocabulary. They have the opportunity to teach collaboratively, exchange ideas, have easier preparations for substitutes, and have more productive common planning times. The teachers report feeling the positive shift from ME to WE in the staff as well as with students.

The point of having educators write STEAM lesson plans to contribute to a commons is two-fold: the first is to verify that they understand how to build a STEAM lesson plan after the training and to receive suggestions on how to make them more well-rounded and polished, the second is to give voice to the educational experts, the teachers in the field, to create a standards-based, live curriculum better than any individual educational program or company can alone. By having STEAM certified teachers contribute at least one lesson plan to the commons, the plans become searchable by the network, and everyone is submitting work that can be used, tweaked, updated, and supported by similarly minded teachers around the world. With the rate of people now contributing, it is hoped that soon educators can pick and choose variations of lessons to build a fully personalized curriculum that works for their students.

Recently, mathematics has rediscovered itself and the study of it now revolves around social constructivism and five related ideas accepted in mathematics:

(1) Mathematics is part of and fits into human culture.

(2) Mathematical knowledge isn't by nature infallible.

(3) There are different versions of proof and rigor, depending on time, place, and other things. The use of computers in proofs is a non-traditional version of rigor.

(4) Empirical evidence, numerical experimentation, probabilistic proof all help us decide what to believe in mathematics. Aristotelian logic is not necessarily always the best way of deciding.

(5) Mathematical objects are a certain variety of social-cultural-historical objects.

Understanding science and mathematics knowledge and practices, as well as technological and engineering practices, has become a priority for national education programs across the world [7]. The United States Next Generation Science Standards (NGSS) includes engineering design and practices as primary elements of science education [8]. The UK has also put forth educational policy agenda promoting science, technology, engineering, and mathematics (STEM) integration both in and out of schools. Germany also created a national STEM forum to promote STEM education for all levels of education, formal and informal.

Design activities provide a context for STEM integration in which learning and application of science

and mathematics concepts and practices occur as students work in teams to find solutions for real-world problems [7]. Studies about STEM programs have found that explicit scaffolding for integration is essential. For example, during simple mechanical device design activities [30], it is found that inexperienced high school students made few connections between designs and science ideas and rarely applied science ideas learned in one activity to another. On the other hand, experts like university engineering design instructors spontaneously made connections to concepts and utilized concepts in making key design decisions. Similarly, Berland and Steingut [29] also found that high school students engaged in engineering design tend to focus on completing design tasks without consistent effort to understand the underlying concepts from mathematics or science. They found that students rarely saw the value of understanding the concepts behind designs. These studies suggest that integrated STEAM learning environments should help students investigate relevant concepts and understand how concepts support design goals. Also, STEAM could be applied to several purposes such as teaching sign language [27], foreign languages [13], [20], [24], or examination platforms [17]. STEAM through the blending of arts and technology could also help educators, regardless of their age, to implement ICT in a more fruitful way in their curiculla without feeling that they are threatened [32].

Whereas there has been some discussion on similarities and differences between scientific and engineering practices [8,9]. There has been a dearth of research on scientific practices as learning outcomes of integrated STEAM programs.

The core element of science and technology as a production tool has also changed the ways that people live and the social structure of society while promoting the arrival of the four industrial revolutions. This wil be of outmost importance in our time as Industry 4.0 an new technologies like Artificial Intelligence and Blockchain dramatically alter the interaction between science and liberal arts [33]. Therefore, the demand for talent type in the future social sustainable development process has also changed with these changes. This kind of change directly puts higher demands on the talent training strategies of various countries. The education of each country has begun to pay more attention to cultivating innovative talents with national responsibility, innovative thinking, and scientific and humanistic qualities.

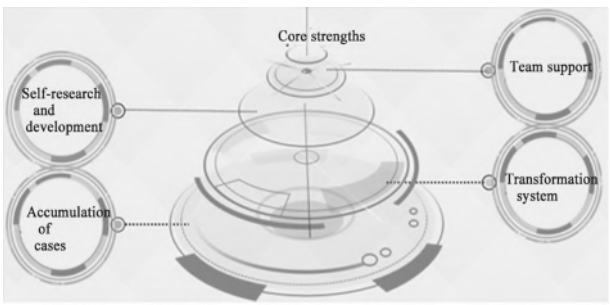


Fig. 4. The core value of a STEAM program.

As for STEAM‘s effects on student learning, several meta-analyses provided an overall picture of the effect. The studies reported that the STEAM initiative, to some degree, achieved intended learning outcomes. Meta-analysis showed that students’ experiences with STEAM were effective in cognitive and affective learning. In particular, the effect was higher in affective domains. Interviews with college students who had STEAM experiences in grade schools showed that the effects could be long-term. These students perceived that their earlier STEAM experience better prepared them for college, and improved competencies such as communication and teamwork skills. On the other hand, the meta-analysis studies showed that there were few significant mediating factors. For example, it was found that student grades, lesson medium, and so on did not have significant effects. Further in-depth research on how STEAM programs interact with students is necessary to understand how those variables function in the classroom

To a certain extent, colleges and universities represent the level of scientific research and development, and universities can reach the most advanced science and technology fields in society, and predict the direction of science and technology development that is required for social development in the future. In the process of cultivating innovative talents, the cultivation of their vision and pattern is also very important. Focusing on the transformation of scientific research topics, the transformation of advanced technology that is “unreachable” into a cognitive curriculum will help participants understand the development trend in advance and clarify future goals.

Deloitte’s report [31] on the IT worker of the future argues that creativity is a key priority and that STEM educators need to embrace the arts to foster students’ creative design and performance, using various media: IT leaders should add an ‘A’ for fine arts to the science, technology, engineering, and math charter – STEAM, not STEM. Designing engaging solutions requires creative talent; creativity is also critical in ideation – helping to create a vision of re-imagined work or to develop disruptive technologies deployed via storyboards, user journeys, wireframes, or persona maps. Some organizations have gone so far as to hire science fiction writers to help imagine and explain moon-shot thinking.

4. STEAM Learning: Combining Science and Art in Europe

When Carl Jung introduced the archetype of the artist-scientist or Albert Einstein stated that science and art derive from the same experience of the mysterious, they repeated a view that had been formulated many years before: that the two fields were inevitably connected. Thus, an A for the English word Arts, meaning Art, effortlessly finds its place in the middle of the STEM (Natural Science, Technology, Engineering, and Mathematics) acronym, which becomes STEAM: a modern, interdisciplinary approach to research and innovation. which is now adopted in school education. The following projects present some of their advantages.

Innovation starts with action – STEAM

Demand for STEM skills is on the rise and is expected to increase by 2025: it is a reality that teachers and school curricula need to take into account. The Innovation project starts with action! STEAM prepares the ground for such a future by adopting three pioneering approaches to further motivate students and increase their participation:

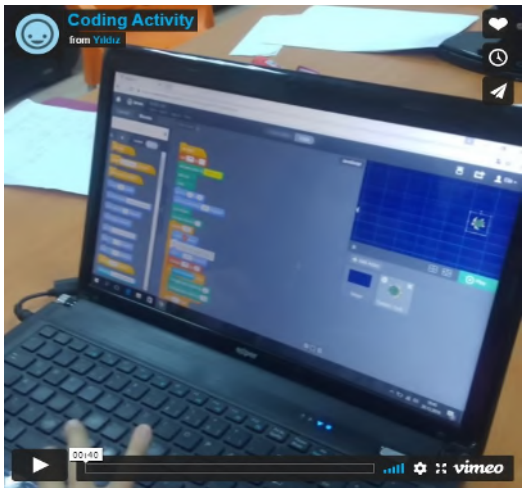
1. Art-in-museum activities
2. Use Lego robots
3. Combination of the above activities in STEAM subjects

The above approaches are especially suitable for primary school students who acquire basic skills in STEAM subjects.

Teachers also used the project as an opportunity to further their vocational training, for example by attending a series of online seminars at the beginning of the project.

The results of the project will be announced through digital platforms, brochures, magazines, staff meetings, exhibitions open to all interested parties, and, of course, the project website, which already has a huge collection of videos. Watch, for example, the video for the meeting in Belfast:

(https://vimeo.com/213491275)



(https://vimeo.com/196568918)

The project started in 2016 and will end in 2018. Seven countries are participating [Turkey (project coordinator)], Italy, the Former Yugoslav Republic of Macedonia, Portugal, Romania, Spain, and the United Kingdom – and funded by Erasmus +.

DLAB

Digital technology, by its very nature, blurs the boundaries, either physically (traditional classrooms) or conceptually (curriculum). The DLAB project aims at an equally free and transversal classroom. To achieve this, it explores three "cross-border learning" topics, one per year: Outdoor Technology, From STEM to STEAM, and Technology-Assisted CLIL (Integrated Content and Language Learning).

The year 2018 was dedicated to STEAM and many resources have been published in the resources section.

Children can compare the artistic and mechanical works of Leonardo da Vinci before starting their own. They can also build an egg-astronaut and predict if their space capsules will provide the necessary protection; they can design their solar panel or deck. Finally, they can create a CD similar to the gold disk that NASA sent into space and all of the above are just a few examples of what they can do.

The project has also released a free MOOC, "STEM to STEAM".

In the long run, DLAB aims to provide sustainability, enrich partners' capabilities, promote international cooperation, even between different sectors, and ensure

active cooperation between cultural institutions and SMEs (small and medium-sized enterprises).

It is a three-year strategic partnership (2016–2019) involving four countries – Denmark (project coordinator), Belgium, Norway, and the United Kingdom - and funded by Erasmus +.

FIND's the full title, Future Innovators, New Discoveries, reveals its dual character: it affects both the identity of STEM professionals and their work. Its goals are:

1. Close the gender gap
2. To develop innovative teaching methods for teaching STEAM and to ensure that teachers feel confident when applying them
3. To develop a methodology that makes the most of modern technologies

The need to intervene on the issue of equality of friends is already clear from the first activity of the project, Draw a Scientist, where the students mostly painted a male scientist. Other activities sought to reconstruct this bias, such as the quiz What STEAM careers would I be suited to? (Which STEM professions suit me?) Or interviews with STEM professionals, who gave the stage to women scientists.

Other training sessions focused on modern teaching methods and one of the partners even set up a learning workshop. Students also had the opportunity to combine technology with art on a variety of occasions: writing code in Scratch, drawing fractions, or getting a taste of robotics, for example.

(https://www.youtube.com/watch?v=rWEpQisSiu8&t=1s)

FIND was a three-year strategic partnership (2016-2019) organized by Greece, Italy, Malta, Norway, Poland, and the United Kingdom. Funded by Erasmus +.

5. Conclusions

For both students and teachers, the arts can be forms of expression, communication, creativity, imagination, observation, perception, and thought. They are integral to the development of cognitive skills such as listening, problem-solving, matching form to function, and decision making. They inspire discipline and dedication. The arts can also open pathways toward understanding the richness of peoples and cultures that inhabit our world, particularly during this period of global change. The arts can nurture a sense of belonging or community; they can foster a sense of being apart or an individual. By acknowledging the role of the arts in our lives and education, we acknowledge what makes individuals whole.

In the language of sustainable development, the strongest ecosystems are those that are the most diverse. That is, diversity is directly related to stability; variety is important for long-term survival. Our success on this planet has been due to an ability to adapt to different kinds of environments over thousands of years (atmospheric as well as cultural). Such ability is born out of diversity. Thus, language and cultural diversity maximize the chances of human success and adaptability.

Elliot Eisner [10] explains that the arts are concerned with expressiveness, evoking emotion, generating empathic

understanding, stimulating imagination that disrupts habits of mind and creates open-mindedness, and eliciting emotional awareness. In sum, the arts enable us to discover our humanity. Such an altruistic goal sits well with education for sustainability.

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