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STEAM APPROACH IN TODAY`S EDUCATIONAL SYSTEM

***Abstract**: STEAM approach is one of the modern approaches that is being widely investigated in the worldwide. It is expected that this approach will enhance teaching subjects in a meaningful way by integrating them and creating interdisciplinary curricular. It is out of the question that Academic English Language is a very important skill for all STEAM (science, technology, engineering, art, mathematics) spheres as without language it would be almost impossible to communicate and deliver the content of the subjects. This article will try to investigate the notion of STEAM, its main principles and components, the ways to design STEAM curricular and what learning theories stand behind it.*

***Key words**: STEAM education, STEAM principles, STEAM curricula, STEAM framework.*

***Language**: English*

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Introduction

Education is changing day after day creating new opportunities for learners to learn in the way that mostly suit their learning styles, personal learning goals and needs. Looking at the footsteps of the development of the education it can be seen that Socrates and Aristotle are the ones who came with the concept that the 'pursuit of knowledge is the highest good' and that this is the basis of education as it is summarized by Georgetta Yakman. It was the basis of the modern educational structure that is still followed in schools and this marked a significant shift from the concept of content-focused curricula to that of promoting a structure of life-long learning. As Yakman presents ideas of Comenius (1947) "it is the Descartes who stated that 'education is a preparation for life'". Georgetta Yakman maintains the idea and says "the common goal of education should be to produce functionally literate people who know how to learn and are adaptable to their rapidly changing environments". It is expected that a developing educational model STEAM would be the approachthat would assist the system to accomplish its function i.e.prepare people for life.Analysing existing National satndardsaof the USA on STEAM and investigating verywellfamily.com web page we can say that the letters stand for "Science" that involves Biology, Chemistry, Physics, Earth and Space science; Technology and Engineering that incorporates practice, skill development and knowledge on information technologies, web design, computer applications, graphic design, app design; Art means Physical Art, Fine Art, Musical Art, Language Art; Mathematics-Algebra, Algebra II, Geometry, Statistics, Trigonometry and/or Calculus. As it is written by Lisa Hoffman and Alan Zollman the term *STEM* was first introduced in 2001 by Judith Ramaley meaning science, technology, engi-neering, and mathematics. But now, J.Ramaley presents Zollman, "STEM has a broader meaning, includingagriculture, environment, economics, education, com-puter science, and medicine". Looking at STEAM can be done through different perspectives. Georgetta Yakmansays that STEAM is based on STEM education, whichcan be defined in two ways:

1. the more traditional way, she writes as S-T-E-M education, as it represents the individual'silo' fields of science, technology, engineering and mathematics education. Each has evolvedto formally include

elements of the others within their own standards and practices.

2. as she summarises Sander and VTSOE the newer trend is the concept of integrative STEM education. It includes the teaching andlearning practices when the subjects are purposefully integrated. AlsoYakman presents G. Wells` findings that when planning integrative curriculum, one field may be the dominant base discipline orall may be planned to be more equally represented.

According to Georgetta Yakmana person cannot understand Science without Technology, which couches most of its research and development in Engineering, which can't be created without an understanding of the Arts and Mathematics.' Yakman mentions that when the disciplines are introduced separately, people are indoctrinated to analyze them and the elements they represent not connecting to each other.Yakman presents Driscoll`s summary of Vygotsky`s point of view on learning who said that people learn by building on the base of knowledge that they already have and the cross-connects of information between those concepts through spiraling and scaffolding. Yakman supports Driscoll`s opinion that it is inevitable that the cross connections will lead them to build up to a collective knowledge that has elements from all disciplines.

According to Zollman"There is a general consensus that everyone needs to be STEM literate, but there is a differencebetween literacy and being literate. STEM literacy should not be viewed as a content area but asa *shifting*, *didactic* means (composed of skills, abilities, factual knowledge, procedures,concepts,and metacognitive capacities) to gain further learning". Hoffmaan and Zollmansupport the idea that literacy in STEMgoes beyond understanding, communicating and applying, "going beyond 'learning to know andlearning to do' to 'learning to live together and learning to be'", "from *learning for STEMliteracy* to using *STEM literacy for learning*".Stacy Zeiger posits that STEAM education is a curriculum philosophy thatempowers science teachers to engage in school-based curriculum development, it provides a creative design spacefor teachers in different learning areas to collaboratein developing integrated curricula.

As it is listed in the CEWD's Internet homepage, P. John Williams and the researchers **Thi Phuoc Lai Nguyen, et.al. consider** the main component of STEAM education is integration of subjects such as science, technology, mathematics, engineering and art by organising well-rounded lessons that occur within the curriculum; project, design, problem and inquiry based, with a focus on interdisciplinary learning where learners are supposed to work collaboratively on projects or solving daily lives problems focusing on processes. While each of these processes have a particular approach and emphasis requiring student engagement that creates student-centered learning. Activities such as generating ideas, researching and investigating, evaluating, modelling their ideas, identifying needs, solving problems, documenting what they do and communicating will get students to practice the important fluid skills they need for their future. John Williams notes Vasquez, Sneider and Comer`s opinion that the goal such initiatives in instilling STEM in classrooms is not to create more scientists, engineers, or mathematicians, but instead to develop capable students who can function in a highly technological world that draws upon multiple disciplines.

In the CEWD's Internet homepage it is asserted that an architect uses science, math, engineering and technology to do their jobs. The subjects do not work on their own, but they are woven together in practical and harmonious ways allowing the architect to design complex buildings so they can be taught together in a way that shows how the knowledge from different fields compliment and support each other. And "A" that stands for Art plays an important role about discovering and creating ingenious ways of problem solving, integrating principles or presenting information. Picture an architect, they use engineering, math, technology, science and arts to create stunning buildings and structures. (https://stem.getintoenergy.com/stem-skills-list/)
Jobs, as it is pointed out by the CEWD webpage, in the real world are interdisciplinary. It is needed to educate learnersto integrate subjects show how they work together. Learners are supposed to develop various skills sets and a passion for exploration and growth. It is not necessary to memorize random facts anymore. People can get access to many facts at their finger-tips now.Education should be about learning how to think critically and evaluate information, how to apply knowledge, research and skills to problem solve. Skills need to be taught in an applied way, as part of a greater whole, rather than the traditional approach of individual subject silos (2021 Center for Energy Workforce Development).

As it is reviewed by Lieve Thibaut, et.al. learning theories are typically divided in three categories: behaviorism, cognitivism and social constructivism. They say behaviorism is centered around the idea that one behavior leads to another and does not take into consideration the functions of the mind. According to behaviorism, knowledge is an organized accumulation of associations and skills that exists outside a person and can be gained through behavior modification. Therefore, learning is seen as a change in behavior that can be conditioned using positive and negative reinforcements such as reward and punishment.

By contrast, Lieve Thibaut, et.al. conclude Ertmer and Newbythat cognitivism focuses on students' internal mental structures and addresses the issues of how information is received, organized, stored, and retrieved by the mind. In accordance with behaviorism, knowledge is considered to exist outside of the person. However,Stavredes states unlike behaviorism, cognitivism focuses on understanding how human memory works to acquire knowledge and promote learning, instead of focusing on behavior. Therefore, learning is seen as the discrete changes between states of knowledge, rather than changes in behavior. Moreover, Lieve Thibaut, et.al. summarizeErtmer and Newby opinion wherelearning is described as a mental activity that entails internal coding and structuring by the student and the student is viewed as an active participant in the learning process.

Lieve Thibaut, et.al. reviewsErtmer and Newby and say that both behaviorism and cognitivism start from the underlying assumption that learning is an individual process. By contrast, they present McKinley`s point of view that social constructivism states that learning is socially situated and knowledge is constructed through interaction with others. They say that as forErtmer and Newby as well as Stavredes, according to social constructivism, students learn by building personal interpretations of the world based on their experiences and interactions with the environment. Therefore, in accordance with cognitivism, the student is seen as an active participant in the learning process (Lieve Thibaut, et.al).

As Thi Phuoc Lai Nguyen et.al. present the cooperative-learning approach is another constructivist pedagogical method that involves students working in small groups to help one another learn. They mention that the aim of STEM education is to equip students with a broad mix of skills and interdisciplinary knowledge. Cooperative learning plays an essential role in helping to develop, spread and sustain the role of education in society. It has been shown to be an effective instructional method that provides a wide variety of outcomes and academic achievements of students. (**Thi Phuoc Lai Nguyen et.al**). **Thi Phuoc Lai Nguyen et.al** review o cooperative learning saying that it builds students' collaborative skills and teamwork—important skills the 21st century, as they are essential for addressing the complexity of present and future socio-economic challenges. Educational approaches based on real-world contexts help students see the relevance of science to their daily lives and enhance their interest and enjoyment in addressing the real-life situations around them. **Thi Phuoc Lai Nguyen et.al present another approach, t**he problem-based learning approach, as another essential instructional practice in integrated STEM education. Problem-based learning is a constructivist pedagogical approach in which students learn about science and develop their skills in critical thinking, problem solving and collaboration by solving real-world problems. The core principles of problem-based learning emerged from cognitivist constructivism and social constructivism. This approach is premised on the theory that students' abilities are developed through social learning. Through working together in a small group and being coached by teachers, students identify problems, formulate hypotheses, collect data, perform experiments, develop solutions and choose the solutions that best "fit" the problems. The problem-based learning approach encourages students to use and build on their knowledge and to work collaboratively in self-organizing small groups to make sense of new information, to solve complex problems, and to produce a solution. The problem-based learning approach enhances students' capacity for thinking and reasoning about problems and integrating previously assimilated knowledge and experience into a life-long learning process. This approach refers to instructional "scaffolding" which plans learning steps. Learning built on prior knowledge and skills and developed through the pathway for new knowledge to be acquired and applied to practice has proved to be executive in STEM education. Through the problem-based learning approach, students' skills including reasoning, critical thinking, application of theory to practice, communication, reflection and teamwork are developed. **(Thi Phuoc Lai Nguyen et.al). Thi Phuoc Lai Nguyen et.al** analyze design-based learning, in which problems are solved using design assignments, is a form of problem-based learning in which students are given hands-on experience of real-world problems. It is an inductive teaching approach built and grounded in the enquiry and reasoning processes leading to the generation of innovative artefacts, systems and solutions. This approach is centered on students' experience of designing a product or object, through which they develop their scientific understanding and problem-solving skills. Design-based learning is considered a promising instructional method to enhance students' learning of and interest in science, and it is commonly applied in teaching science and design skills and to engage secondary school students in engineering design tasks.(**Thi Phuoc Lai Nguyen et.al**)

There are five distinctive terms that should be presented and looked at investigating STEAM education. They are Silo, Embedded, Integrated, interdisciplinary, multidisciplinary, transdisciplinary of STEAM teaching. Amanda Roberts Diana Cantu point out the distinction between s*ilo*, *embedded*, and *integrated* approaches lies in the degree of STEM content used. Amanda Roberts Diana Cantu summarises Dugger`s consideration saying that the s*ilo* approach to STEM education refers to isolated instruction within each individual STEM subject. Concentrated study of each individual subject allows the student to gain a greater depth of understanding of course content. *Silo* STEM instruction is characterized by a teacher-driven classroom. Morrison states students are providedlittle opportunity to "learn by doing", rather they are taught what to know (Amanda). it is possible *silo* instruction may encourage students to maintain a segregated perception of content courses. Without practice Breiner et.al. say that students may fail to understand the integration which naturally occurs between STEM subjects in the real-world (Amanda).While an instructor may choose to implement a variety of teaching strategies, in a *silo* classroom, the content would likely remain the focus of study. This may limit the amount ofcross-curricular stimulation and student understanding of the application of what they must learn.

As it is presented in ITEEA, 2007 e*mbedded* teaching is effective instruction because it seeks to reinforce and complement materials that students learn in other classes(Amanda). E*mbedding* differs, Rossouw et.al. states, from the *silo* approach in that it promotes the learning through a variety of contexts (Amanda). However, Chen claims that the *embedded* material is not designed to be evaluated or assessed (Amanda). In embedded teaching domain knowledge from at least one discipline is placed within the context of another.

Hmelo and Narayan argues that the *embedded* approach may lead to fragmented learning (Amanda). If a student cannot associate the *embedded* content to the context of the lesson, the student risks learning only portions of the lesson rather than benefiting from the lesson as a whole. Additionally, it is essential to ensure the *embedded* components are something the student has prior learning and are grade level appropriate. As Novack mentions, If the instructor has to stop and teach or remediate a student on the *embedded* knowledge, the students' learning may be disrupted (Amanda). As stated by Breiner et al. along with Morrison& Bartlett an *integrated* approach to STEM education envisions removing the walls between each of the STEM content areas and teaching them as one subject (Amanda). In the opinion of Sanders` i*ntegration* is distinct from *embedding* in that it evaluates and assesses specified standards or objectives from each curriculum area that has been incorporated within the lesson (Amanda). On the authority of Harden, ideally, integration enables a student to gain mastery of competencies needed to resolve a task (Amanda).

Three common approaches to integrative instruction are multi-disciplinary, trans-disciplinary and interdisciplinary integration.As Willie Caldwell presents according to Oxforddictionaries.com:

Multidisciplinary is an adjective that describes, "combining or involving several academic disciplines or professional specializations in approach to a topic or problem."

Interdisciplinary is an adjective that describes, "of or relating to more than one branch of knowledge."

Transdisciplinary is also an adjective that describes, "relating to more than one branch of knowledge."

Willie Caldwell says according to Lakehead University's "Essential Guide to Writing Research Papers," multidisciplinarity contrasts disciplinary perspectives in an additive manner, meaning two or more disciplines each provide their viewpoint on a problem from their perspectives. Multidisciplinarity involves little interaction across disciplines.*Multidisciplinary integration* asks students to connect content from various subjects taught indifferent classrooms at different times. It relies on corroboration between faculty members to ensure content connections are made (Wang et al., 2011).

Interdisciplinarity combines two or more disciplines to a new level of integration suggesting component boundaries start to break down. Interdisciplinarity is no longer a simple addition of parts but the recognition that each discipline can affect the research output of the other.Wang et al. (2011) explain *interdisciplinary integration* begins with a real-world problem. It incorporates cross-curricular content with critical thinking, problem-solving skills, and knowledge in order to reach a conclusion. *Multidisciplinary integration* asks students to link content from specific subjects, but *interdisciplinary integration* focuses students' attention on a problem and incorporates content and skills from a variety of fields.

Transdisciplinarity occurs when two or more discipline perspectives transcend each other to form a new holistic approach. The outcome will be completely different from what one would expect from the addition of the parts. Transdisciplinarity results in a type xenogenesis where output is created as a result of disciplines integrating to become something completely new.

Instructing through integrative approaches requires pedagogical training. This may hinder students' understanding due to a lack of general structure within the lesson, a phenomenon referred to as the potpourri effect (Jacobs, 1989). In the potpourri effect, teachers incorporate material from each discipline, but they fail to create one common objective.Perhaps even more detrimental than the potpourri effect is the polarity effect. Teachers may become territorial over specific subject matter limiting the incorporation of other content. This may lead to a lack of understanding by students (Jacobs, 1989). Careful consideration must be made when choosing the appropriate method of instruction. Each method discussed offers strengths and challenges which must be addressed when implemented.According to review done by Lieve Thibaut et.al. STEAM framework contains five key principles: integration of STEM content, problem-centered learning, inquiry-based learning, design-based learning and cooperative learning. Many studies have shown that the following key principles are necessary for integrated STEM education in secondary schools to address sustainability: the integration of STEM content; enquiry based on the real world; and problem-centred, design-based, and cooperative learning approaches. Hence, the interdisciplinary and real-world problem-based works are engaged in STEM pedagogical practices and curriculum and material designing.

On the report of Dr. Richard L. Biffle III the STEAM framework can be best understood in a diagram that illustrates the nature of the relationship between content, disciplines, interdisciplinary and multidisciplinary instructional approaches, problem-based inquiry and research, and life-long holistic-learning habits of mind. The terms associated with the framework are “defined” in the following manner:

- Lifelong learning – Interdisciplinary, Multidisciplinary and Holistic/Lifelong Learning
- Project/Problem-based inquiry and research – Integrates knowing and doing.
- Interdisciplinary/Multidisciplinary – using the terms problem-focused process, sharing, and working together and in the case of STEAM organized in an integrated curricular instructional deign format
- Discipline Specific – Science, Technology, Engineering, Arts, Mathematics
- Content Specific - refers to the facts, concepts, theories, and principles that are taught and learned,rather than to related skills

Due to its interdisciplinary nature,

STEM education is seen as both a curricular and a pedagogical approach (**Thi Phuoc Lai Nguyen et.al)**. In terms of curriculum, STEM education refers to the interdisciplinary framework, whereas pedagogical approaches center around instructional practices such as enquiry through representations, problem solving and reasoning, challenge-based learning, design-based approaches and digital technologies(**Thi Phuoc Lai Nguyen**).

References:

1. Roberts, A., & Cantu, D. (n.d.). *Applying STEM Instructional Strategies to Design and Technology Curriculum*. (pp.111-118).
2. Eshbekovich, P. J. (2020). “STEAM” - education as an innovative approach to the development of vocational training for students. *European Journal of Research and Reflection in Educational Sciences*, Vol. 8 (No. 3), 101-105.
3. HyunJu Park, S.-y. B. (2016). Teachers’ Perceptions and Practices of STEAM Education in South Korea. Eurasia Journal of Mathematics, *Science & Technology Education* , 12(7), 1739-1753. doi:10.12973/eurasia.2016.1531a
4. Hoffman, L., & Zollman, A. (2016) "What STEM Teachers Need to Know and Do for English Language Learners (ELLs): Using Literacy to Learn," *Journal of STEM Teacher Education*: Vol. 51: Iss. 1, Article 9. Available at: http://ir.library.illinoisstate.edu/jste/vol51/iss1/9
5. Henriksen, D. (2017) "Creating STEAM with Design Thinking: Beyond STEM and Arts Integration," *The STEAM Journal:* Vol. 3:Iss. 1, Article 11. DOI: 10.5642/steam.20170301.11 Available at: http://scholarship.claremont.edu/steam/vol3/iss1/11
6. III, D. L. (2016, June). *Introduction to STEAM (Science, Technology, Engineering, Arts, and Mathematics) – Course Design, Organization and Implementation*. THOMAS COLLEGE.
7. Sotomayor, K. (2013, January/February). *Teaching STEM to English language learners. Ten to teen*. www.naesp.org.
8. Taylor, P. C. (2018). *Enriching STEM with the Arts to Better Prepare 21st Century Citizens*. ResearchGate, (pp. 02002-1/02002-5).
9. Taylor, P. P. (2016). *Why is a STEAM curriculum perspective crucial to the 21st century?*
10. Thi Phuoc Lai Nguyen, T. (2020). *STEM Education in Secondary Schools: Teachers’ Perspective towards Sustainable Development*. Sustainability MDPI.
11. Thibaut, L., Ceuppens, S., De Loof, H., De Meester, J., Goovaerts, L., Struyf, A., Boeve-de Pauw, J., Dehaene, W., Deprez, J., De Cock, M., Hellinckx, L., Knipprath, H., Langie, G., Struyven, K., Van deVelde, D., Van Petegem, P. & Depaepe, F. (2018). Integrated STEM Education: A Systematic Review ofInstructional Practices in Secondary Education. *European Jourrnal of STEM Education*, 3(1), 02. https://doi.org/10.20897/ejsteme/85525
12. Yakman, G. (2018). *STEAM Education: an overview of creating a model of integrative education*. Research Gate.

13. Zeiger, S. (n.d.). *Bringing STEM to the ESL/ELL Classroom.* Retrieved from http://busyteacher.org
14. Williams, J. (n.d.). *The Principles of Teaching and Learning in STEM Education Curtin University*.