STEAME Learning with Entrepreneurial Mindset: Implementation in Hybrid Environments

Grigore Albeanu, Rodica Ioan
Scientific Research Center in Mathematics and Computer Science,
SHU STEAME Regional Academy,
Spiru Haret University
Bucharest, Romania
email: g.albeanu.mi@spiruharet.ro, r.ioan.mi@spiruharet.ro

***Abstract*— This paper addresses STEAME (Science, Technology, Engineering, Arts, Mathematics, and Entrepreneurship) education for both pre-service and in-service teachers, utilizing digital open education resources through blended learning and hybrid environments. The main contributions aim to foster the development of entrepreneurial attitudes and skills through learning and teaching across the whole curriculum using modern technologies in hybrid environments. This approach promotes everyone's entrepreneurial capacity and supports their experiential understanding of the diverse real-world professional context, including its complexity within hybrid environments. Moreover, building the 'can do' mindset through 'hands-on' entrepreneurship experience within the teaching and learning dynamics using interactive multimodal open education resources is emphasized. Additionally, tangible examples, ideas, and tools to inspire and assist educators in planning their own entrepreneurship mindset-based project are provided. Projects such as Sweet Hive Venture, Art Studio/Business, Premium Herbal Wellness and Alpha/Omega Fintech are presented to give a broad view on implementation of STEAME education with an entrepreneurial mindset. Results reflecting the impact of the proposed approaches were obtained for two days training activities in May-October 2025 and are presented to outline some good practices in STEAME education.**

Keywords - Education 4.0; STEAME education; hybrid environments; blended learning; project-based learning.

I. INTRODUCTION

The STEM acronym is used when combining curriculum of science, technology, engineering, and mathematics to elaborate about how things evolve. Although the STEAM approach is relatively recent [1], the idea of integrating science, technology, engineering, and mathematics into educational curricula dates to before 1900. According to [2], STEM integration "traces back to the Morrill Act of 1862, which created land grant universities to promote agricultural science." A few years ago, due to the "Educate to Innovate" Campaign by President Obama, USA has started to prepare 100,000 STEM teachers by 2021 and called for increasing federal funding toward STEM education [3].

STEAM is an expansion of the original acronym STEM, to which "Art" has been added to promote a greater sense of creativity [4]. The "Entrepreneurship" element in STEAME (Science, Technology, Engineering, Arts, Mathematics, and Entrepreneurship) is the catalyst that turns a creative school project into a purposeful innovation, teaching students that their creativity has tangible economic or social value.

The following sections are structured as follows: Section 2 presents the Education 4.0 framework, Section 3 outlines Learning and Creativity Plans (L&CP) from an entrepreneurial perspective, Section 4 describes the implementation details, and Section 5 offers reflections and directions for future work. This educational research suggests that the Entrepreneurship (E) component acts as a connecting element that brings the framework together in a purposeful way.

II. FROM LESSON PLANS TO LEARNING AND CREATIVITY PLANS IN EDUCATION 4.0 FRAMEWORK

A. Education 4.0 Framework

The shift from Lesson Plans (LP) to Learning and Creativity Plans (L&CP) marks a departure from "industrialized" education toward a personalized, tech-driven, and student-centric approach. In the STEAME context, this transition is vital because it moves the focus from delivering content to cultivating innovation.

TABLE 1. EDUCATION FRAMEWORKS

Stage	Orientation	Pedagogical approach
Education 1.0	Only memorization, not oriented towards understanding	Teacher-centered; lectures given and memorization tests.
Education 2.0	Communication oriented	Group learning; more interaction but still standardized.
Education 3.0	Knowledge-based	Student-centered; Self-directed learning and early technology.
Education 4.0	Driven by innovation	Focused on AI-powered, personalized, and 21st century-specific core competencies.

Education 4.0 is essentially the educational response to Industry 4.0, the fourth industrial revolution characterized by smart technology, Artificial Intelligence (AI), and the Internet of Things (IoT) [5][6]. In Education 4.0, the teacher is no longer the "sage on the stage" but a facilitator of experiences (see Table 1). The L&CP are focused on the student's journey, not necessarily following a standard curriculum, outlining the environment, the digital tools, and the "open-ended" challenges that allow students to find unique solutions by blending the subjects to mirror real-world problem-solving along S-T-E-M (providing analytical foundation and technical tools), Arts (A) for design, aesthetics and communication, and Entrepreneurship (E).

The most important pillars of Education 4.0 are based on the following facts [5]:

1) Artificial Intelligence (AI) and data analytics allow for *adaptive learning*, where the curriculum adjusts to a student's strengths and weaknesses. If a student understands a concept quickly, they move on; if they struggle, the system provides additional support immediately.

2) Memorization has a lower intensity while the priorities are directed towards *critical thinking* (analysis of facts not only their registration), *creativity* (human-oriented activity, not AI) and *collaboration* (working in hybrid environments).

3) Learning can happen *anywhere, anytime*. This way of thinking is based on *blended learning*, and *mobility-based learning* from classroom to practice spaces or companies, which means also *hybrid environments*. *Flipped classrooms* and *AI-driven tutoring platforms* become the norm in many forward-thinking *schools*.

4) Education 4.0 emphasizes *learning by doing*, which means *Project-Based Learning (PBL).* Instead of just reading about biology, students might use science to simulate an optimization method based on the bees-algorithm. This prepares them for understanding life, society, and their future behavior [6].

5) Education 4.0 instills a *growth mindset*, teaching students how to continuously *upskill* and *reskill* throughout their lives, considering a strong contribution to society and community by *innovation*, and improving *life for all*.

B. Designing L&CP to support STEAME education

The L&CP are typically built on the following five design principles [7]:

1) **Transdisciplinary integration**: How do we provide clean water to a local community? The plan maps out how Science (chemistry of water) and Arts (graphic design for awareness) communicate through a shared language.

2) **The 4D process** (*Discover, Define, Develop, and Deliver)* defines the design thinking process.

3) **Multimodal communication**: The L&CP require students to communicate using Linguistic, Visual, Aural, Gestural, and Spatial skills: Pitching ideas to "investors" as in Entrepreneurship.

4) Designate specific **Reflection Points** where students will communicate their failures and pivots (soft skills), not just their successes.

5) The L&CP should identify a **target audience** beyond the teacher. Whether it is a blog post, a community presentation, or a prototype demo, the communication must be tailored to real stakeholders.

In Education 4.0, the *Entrepreneurship* element turns a student into a *producer* rather than a *consumer.* The L&C Plan must therefore include "*Market Feedback*" loops — teaching students to listen to user's needs and communicate the value proposition of their technical work [7].

According to [7], all L&CP will be composed of sections addressing the following aspects:

- The headings describing the STEAME framework will cover ST/TS cooperation at the stages of the action plan.
- Learning goals and objectives, learning outcomes and expected results, and the proposed methodologies will display the objectives of L&CP.
- Working spaces, the required tools and resources should be specified to support the implementation of the L&CP.
- The implementation phase will define all activities, procedures and reflections, including the project evaluation, reporting and sharing best practices and pivoting points.

III. NEW L&CP IN STEAME EDUCATION

A. Overview

This section describes eight L&CPs designed for use by Student Teachers (ST) and Teachers in Service (TS). In the L&CPs in Table 2, at least two trainers are involved, while in the L&CPs in Table 3, at least three trainers are required to conduct the projects.

TABLE 2. L&CP FOR STUDENT TEACHERS

Project title	Age/Classes	Number of teachers/STEAME domains
Sweet Hive Venture	15-18/10-12	3/*T1(Biology/Agriculture/ Forestry, T2(Math), T3(Entrepreneurship)*
Art Studio	15-18/10-12	3/*T1(History), T2(Art), T3(Entrepreneurship)*
Herbal Wellness	12-15/5-10	3/*T1(Biology), T2(Chemistry), T3(Technologies)*
Alpha Trust Fintech	14-16/10-12	2/*T1(Math), T2(Economics)*

Both ST and TS use games to increase engagement, foster collaboration, and enhance learning across subjects like history, science, and math [8]. Gamification by integration of game-based learning to support STEAME education is a challenging task depending on trainers' competencies, technologies required and the L&CP design.

In the projects above, a total of six hours of study are allocated (typically comprising 4 to 6 activities), involving multiple trainers to interconnect disciplines and highlight their importance for society. For instance, "Art Business" implementation requires a teacher (T4) having strong background in Information and Communication Technologies (ICT) to facilitate the implementation of a small e-commerce platform.

TABLE 3. L&CP FOR TEACHERS IN SERVICE

Project title	Age/Classes	Number of teachers/STEAME domains
Sweet Hive Venture	15-18/10-12	4/*T1(Biology/Agriculture/ Forestry, T2(Technology) T3(Math), T4(Entrepreneurship)*
Art Business	15-18/10-12	4/ *T1(History), T2(Art), T3(Entrepreneurship), T4(ICT)*
Premium Herbal Wellness	15-18/10-12	4/*T1(Biology), T2(Chemistry), T3(Technologies) T4 (Entrepreneurship)*
Omega Trust Fintech	17-18/11-12	3/*T1(Math), T2(Economics), T3(Entrepreneurship))*

In the following subsections we present short extracts from the L&CPs to illustrate the proposed approach.

B. Sweet Hive Venture – Developing skills

In terms of developing critical thinking, problem-solving, and collaboration skills the L&CP should address:

b1. Beekeeping and Sustainability Program

Entrepreneurship Business planning, marketing, and selling honey and wax products.

Biology Bee anatomy, life cycle, and pollination process. Sustainable beekeeping practices, biodiversity conservation.

Mathematics Budgeting, cost analysis, and financial planning.

Parents Involvement through workshops, honey tasting events, and community engagement.

b2. Mathematics and Data Analysis in Beekeeping:

Entrepreneurship Using data for informed business decisions.

Biology Analyzing bee behavior and population trends. Monitoring hive health through data analysis.

Mathematics Statistical analysis, hive productivity calculations.

Parents Involvement in data collection and analysis workshops.

b3. Ethical Business Practices and Social Impact:

Entrepreneurship Integrating ethics into business decision-making.

Biology Ethical considerations in beekeeping. Measuring and communicating the environmental impact.

Mathematics Quantifying social and environmental impact.

Parents Participation in discussions on ethical business practices.

C. Art Studio/Business – a PBL approach

The most important aspects in implementing PBL activities are related to Motivation, Methodology, Strategies and Scaffolds. Motivating students to get involved in "Art Studio/Business" project was achieved by highlighting various aspects that appeal to their interests, aspirations, and personal development. Some of the most important follows:

c1) Engaging in practical, experiential learning opportunities.

Students can participate in recreating historical events on a postcard to reveal the importance of knowing history in real life.

c2) Developing entrepreneurial skills and business acumen.

Students can learn about running a sustainable business, from product development to marketing, fostering a spirit of entrepreneurship.

c3) Exploring science, technology, engineering, arts, mathematics, and entrepreneurship (STEAME) concepts.

"Art Studio/Business" involves history (painting as a medium for recording and interpreting historical events), art (paintings commissioned to glorify rulers, celebrate military victories, or reinforce religious beliefs), and technology (digital skills-to create online "Art Business"), offering a multidisciplinary STEAME experience.

c4) Exploring creative product development and innovation.

- Designing and creating postcards which reconstruct historical events allows students to express their creativity and innovation in a real-world business setting.
- Designing and building the e-commerce platform for "Art Business".

c5) Making a positive impact on the local community.

Participating in community engagement events, workshops, and initiatives allows students to contribute to raise awareness about the importance of history and art.

c6) Developing leadership skills and responsibilities.

Students took leadership roles within the program, leading teams, organizing events, and actively contributing to the success of "Art Studio/Business" project.

c7) Building social connections and teamwork skills.

Collaborating with peers, educators, and community members fosters a sense of camaraderie and teamwork, creating a positive social environment.

Participants in "Art Studio/Business" can highlight resumes and college applications, potentially leading to opportunities in history and art studies, business related in the art domain, or related fields.

By emphasizing the above selection of motivations, "Art Studio/Business" L&CP can be viewed like a program that resonates with a diverse range of student interests, encouraging active involvement and a positive learning experience. It guides students through key themes, artists, and historical contexts, encouraging critical thinking, analysis, and discussion.

D. Premium Herbal Wellness – Action Plan Formulation

The objective of this L&CP is to describe how teachers (ST/TS) can approach STEAME education to empower high-school students with entrepreneurial skills by establishing a sustainable "Premium Herbal Wellness" business taking into account aspects like safety, quality, dosage, interaction and appropriate usage of medicinal herbs as supplementary sources for someone health or beauty (by herbal cosmetics).

The following topics are covered by the four teachers involved in projects, formulating hypotheses about the medicinal herbs, their interaction and technical aspects in the context of botany, biochemistry and biotechnologies. Teacher 4 is business oriented.

d1) Activities of Teacher 1:

1. Adapt botany concepts for grade level.
2. Explain Plant Life Cycles, the parts, and the economic value.
3. Present use cases (Skin care/ Anti-aging Treatment/Skin Protection/Antioxidants/Hair care/Essential oil etc.) to treat or prevent disease, to "maintain" health and for cosmetic use.
4. Encourage observation, classification, gender-specific differentiation.

d2) Activities of Teacher 2:

1. Adapt biochemistry concept for grade level.
2. Explain the basic chemical components and the molecules to understand the plants' biochemistry.
3. Encourage observation and experiment.

d3) Activities of Teacher 3:

1. Adapt biotechnology concepts for grade level.
2. Explain the role of biotechnologies for herbs, tools for quality control of herbal products, introduce students to the Phyto pharmacy field and cosmeceuticals.
3. Encourage students to develop a simple medicinal product and measure the basic characteristics.
4. Encourage students to make simple moisturizing cream or perfume.

d4) Activities of Teacher 4:

1. Explain basic entrepreneurship concepts.
2. Discuss global trends in Herbal Market.
3. Push the interest in developing product niches.
4. Discuss regulations and how to certificate a new project.

Common activity: Discuss the opportunity to design a new combination of herbs to increase the immunity of people/new herbal cosmetics for beauty or restoration. Design a strategy to promote the product to set up an entrepreneurial desire for students.

E. Alpha/Omega Fintech - Instructional Activities, Procedures, Reflections

This subsection presents a STEAME PBL proposal involving 3 teachers (T1 - Math, T2 – Economic Science, T3 – Entrepreneurship) working as a team along five activities.

TABLE 4. STEAME PBL FOR FINTECH

Activity	Who	Tasks
1. Introduction to Financial Education	T1	1.1.1 Introducing the students to mathematical calculations needed and to interpretation and meaning. 1.1.2 Introducing basic notions used in financial and actuarial mathematics. 1.1.3 Presenting basic procedures for data processing under statistical mindset. 1.1.4 Incorporating technology to make the learning experience more dynamic.
	T2	1.2.1 Introducing the main notions about budget management. 1.2.2 Describing basic concept of investing and how it can help to raise money over time.
	T3	1.3.1 Introducing the structural organization of an insurance company and the types of insurance agents.
2. Actuarial Mathematics	T1	2.1.1 Explaining the role of actuaries. 2.1.2 Introducing the concept of expected value. 2.1.3 Encouraging students to find an example of risk management in real life.
	T2	2.2.1 Explaining the importance of Insurance. Presenting different types of insurance: health, auto, home, and life. 2.2.2 Providing students with handouts that include real-world actuarial problems and solutions. 2.2.3 Discussing the education and skills needed to become an actuary.
	T3	2.3.1 Explaining the types of services offered by an insurance company/agency.
3. Life Insurance Policy	T1	3.1.1 Introducing the main notions to understand: Risk and insurance 3.1.2 Defining Annuity. 3.1.3 Explaining the main types of Annuities: Fixed Annuities, Variable Annuities, Immediate Annuities, Deferred Annuities.
	T2	3.2.1 Discussing real-life examples. 3.2.2 Inviting a financial planner or insurance agent to speak to the class about their work and answer questions.
	T3	3.3.1 Discussing how to describe Quantities, Change, Benefits, and Structure of the market.

4. Practical Aspects of Life Insurance	T1	4.1.1 Introducing procedures to solve a mathematical problem with help of mathematical software (R/Python programming, Sheets) 4.1.2 Working into small groups. Give each group a scenario (e.g., a car accident, a house fire). Each group decides how much they would pay for insurance and what the insurance would cover. 4.1.3 Discussing each scenario and how insurance helps managing the risk.
	T2	4.2.1 Presenting a short video explaining annuities and their benefits for long-term savings and financial security. 4.2.2 Working into small groups. Give each group fake money and an annuity contract. Let them decide how much money to put into their annuity each month. Simulate a few years and then start paying out the annuity. Show how their decisions affect their pay. 4.2.3 Fostering teamwork by assigning roles in event planning, promotion, and execution.
	T3	4.3.1 Show how to be an insurance agent.
5. Career Paths in Insurance	T1	5.1.1 Discussing the role of an actuary. Actuaries evaluate complex risks and assess the potential financial consequences involved. Typical duties include analyzing statistical data – for example, medical information about people of a particular age group, computer modeling statistics to determine potential risks and to explore ways to reduce them.
	T2	5.2.1 Discussing principles of insurance. Insurers offer indemnity against clients' losses. That is, they provide funds to compensate clients for losses.
	T3	5.3.1 Discussing the difference between banks and insurance companies. 5.3.2 Discussing the benefits and risks for insurance companies and why reinsurance is necessary. 5.3.3 Presenting use cases for insurance/reinsurance in various fields like: pension, accidents and health, life, property and casualty, kidnap and ransom etc.

According to our vision, the student activities are important as well. Some examples of tasks follow:
1. Fill a simple budget template based on a hypothetical income and expenses scenario.
2. Create a simple game with probabilities and outcomes.
3. In small groups, students create a budget for a common scenario (e.g., planning a birthday party within a budget).
4. Discuss and understand the importance of actuarial mathematics.
5. Students are encouraged to discuss how actuaries work in insurance, finance, and other industries to help companies make smart decisions.
6. Design a poster to underline how actuaries might calculate the probability of an event like a car accident or a natural disaster.
7. Understand and discuss the fundamental concepts of insurance and annuities.
8. Make a poster with the risk activities and insurance activities.
9. Create multimedia projects related to insurance and risk management, highlight the projects in school exhibitions or community events.
10. Create a game of insurance business.
11. Play an insurance game.
12. Disseminate in social media the new gained experience.

F. Assessment – Evaluation

In the following will be discussed aspects on assessment & evaluation only related to "Alpha/Omega Fintech". Similar tasks are planned for any STEAME project.

The formative assessment will ask teachers to check for understanding through classroom discussions, and how teachers will help facilitate discussion and correct misconceptions, if necessary. Moreover, the exit ticket at the end of the lessons will help gauge student understanding. Therefore, the opening discussion will allow teachers to check for understanding of the material as well as the end of class discussion about the results.

A special interest should consider the continuous formative evaluation which involves:

- *Quizzes and Problem-Solving Exercises:* Regular quizzes assessing knowledge of budget management (income, expenses, savings), spending wisely, concept of investing and how it can help grow money over time, expected value, insurance, insurance policy, risk management.
- *Group Presentation Rubrics*: Evaluating group presentations about the concepts of insurance and annuities focusing on accuracy in data representation, depth of analysis, and understanding of this process.
- *Calculation Accuracy Checks*: Assessing the accuracy of calculations made during sessions related to a budget, cost analysis, insurance policy, life insurance policy
- *Peer and Self-Assessment*: Encouraging students to assess their and their peers' work during group activities, fostering a reflective approach on understanding and teamwork.

IV. IMPLEMENTATION IN HYBRID ENVIRONMENTS

A Hybrid Learning Environment (HLE) is a mixture of School-Based Learning (SBL) - where "learning is central" and Work-Based Learning (WBL) - where "working is central", as described in [9][10]. Recently, the term hybrid referred also to face to face and online learning (or ICT-based learning). According to [9], SBL "*can be characterized as intentional, organized in a formal curriculum, with predictable outcomes and with a focus on explicit knowledge and generalized skills*". By contrast, WBL is "*unintentional and informal*" [9] and is promoted in vocational and technical education [10].

STEAME education uses multidisciplinary-based PBL being suitable for HLE. For the STEAME projects described in Section 3, we considered all three ways: SBL, WBL, and online (mobile) learning using Open Educational Resources (OER) depending on L&CP. OER items are offered by schools or online platforms like PhET [11] and STEAME repository [12].

Figure 1. School-based learning.

Figure 2. Open space/ work-place learning.

The L&CP described above were discussed and evaluated for two days training activities in May 2025 for 16 ST and 10 TS (Figure 1) and in October 2025 (25 TS). The evaluation rubric covered competences, project management, project development and project implementation. Four degrees of performance (1 – initial, 2 – developing, 3 – strong, 4 – exemplary) are collected and analyzed to improve L&CP design. The classification was based on labels: *limited* (0-30%), *adequate* (30-60%), *great* (60-80%), and *excellent* (80-100%). The following results were obtained: adequate (3 L&CP), great (5 L&CP).

Figure 2 displays a learning activity in open space / workplace. OER videos were created for all L&CP to explain their structure. OER interactive lessons are under development.

V. CONCLUSION AND FUTURE WORK

This work presented the design of L&CP according to STEAME-PBL approach to foster the development of entrepreneurial attitudes and skills through learning and teaching across the whole curriculum using modern technologies in HLE. The L&CPs have been implemented using SBL, WBL, blended learning, and HLE approaches.

The present work will continue with specific OER development and their registration on STEAME platform [12].

ACKNOWLEDGMENT

The L&C plans were developed by authors during the co-funding stage according to the agreement between *Spiru Haret* University and the project 101102619: STEAME TEACHER FACILITATORS ACADEMY.

REFERENCES

[1] NSF, "NSF's history and impacts: A brief timeline" [ONLINE] https://www.nsf.gov/about/history 2026.04.13.

[2] STEMSchool, "Rich history of STEM education in the United States", https://www.stemschool.com/ articles/rich-history-of-stem-education-in-the-united-states 2026.04.13.

[3] The White House, "President Obama launches "Educate to Innovate" campaign for excellence in science, technology, engineering & math (Stem) education," 2009, [ONLINE] Available from: https://obamawhitehouse.archives.gov/the-press-office/president-obama-launches-educate-innovate-campaign-excellence-science-technology-en 2026.04.13.

[4] L. Gavrilas and K. T. Kotsis, "The evolution of STEM education and the transition to STEAM/STREAM," Aquademia, 9(1), ep:25002, May 2025.

[5] T. Huk, "From Education 1.0 to Education 4.0 – Challenges for the contemporary school," The New Educational Review, Apr. 2021, [ONLINE] Available from https://czasopisma.marszalek.com.pl/uploads/periodicals/tner/202104/tner6603.pdf 2026.04.13.

[6] A. Bondin and J. P. Zammit, "Education 4.0 for Industry 4.0: A mixed reality framework for workforce readiness in manufacturing," Multimodal Technol. Interact., 9(5), 43, https://doi.org/10.3390/mti9050043, 2025.

[7] G. Makrides, "Guidelines for developing and implementing STEAME schools," [ONLINE] Available from: https://steame.eu/wp-content/uploads/2021/11/STEAME_LC-Handbook-EN-updated-26.11.2021.pdf 2026.04.13.

[8] C.-H. Lai and P.-Y. Hu, "The gaming revolution in history education: The practice and challenges of integrating game-based learning into formal education," Information; 16(6),490, 2025, doi:10.3390/info16060490.

[9] I. Zitter and A. Hoeve, "Hybrid learningeEnvironments: Merging learning and work processes to facilitate knowledge integration and transitions," OECD, 2012 [ONLINE] Available from: https://www.oecd.org/en/publications/hybrid-learning-environments_5k97785xwdvf-en.html 2026.04.13.

[10] I. Tobback, D. Verhaest, and K. De Witte, "The impact of work-based versus school-based learning on cognitive and non-cognitive outcomes in vocational secondary education," Discussion paper series DPS 25.10, May 2025 [ONLINE] Available from: https://feb.kuleuven.be/research/economics/Documents/DPS2025/DPS%202510.pdf 2026.04.13.

[11] PhET, Available from: https://phet.colorado.edu/ 2026.04.13.

[12] The STEAME platform observatory, [ONLINE] Available from: https://federation-steame-academies.eu/ 2026.04.13.