LEARNING & CREATIVITY PLAN (L&C PLAN): STEAME in the work of entrepreneurs, scientists, artists

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1. Overview

Title	Research on the STEAME aspects in the work of entrepreneurs, scientists, artists – case studies by Leonardo da Vinci and Elon Musk (Tesla)
Driving Question or Topic	What are the key success factors that I can identify, analyze and
Ages, Grades, …	**Ages 13-18** **7th - 12th grade**
Duration, Timeline, Activities	24 learning hours 36*40 minutes 1 project/team
Curriculum Alignment	Entrepreneurship classes in 10th grade
Contributors, Partners	
Abstract - Synopsis	Students are divided in teams of 4-5 in their classes of Entrepreneurship and do research on the work of Elon Musk (Tesla) and Leonardo da Vinci. All teams present final results in their presentations with key conclusions and analysis of the success factors. The main approach, applied in the process is using the inquiry-based learning based on the study of cases for interdisciplinary scientific, social, project and business realizations, as in addition to gather and analyze the necessary information, in order teachers and students to identify disciplinary and interdisciplinary links with studied, in previous periods or at present, subject areas. The following scientific areas are included in the research project of teachers and students - Mathematics; Arts; Physics; Chemistry; Biology; Anatomy.
References, Acknowledgements	

2. STEAME Framework*

Teachers' Cooperation	**Teacher 1** is the main teacher – in Entrepreneurship and Economics who works in cooperation with the other teachers: in Science (Chemistry and Physics), Technology (IT, Computer Science), Math, Arts. T1 provides the workplan and main tasks for all teams starting with the division of teams and assigning one topic to each one of them: Science, Technology and Engineering, Arts, Math, Entrepreneurship.
STEAME in Life (SiL) Organization	**Teacher 2 is in Science – Chemistry, Biology, Physics.** Teaching scientific elements and topics and guidelines for students how to conduct scientific research, bibliography quotations, **references**, credible sources of information. T2 mentors one team and supports the project work with questions and particular tasks aligned with the main plan and workflow provided by T1. **Teacher 3 is in Computer science/IT**

	T3 mentors one team working on the topic Technology and Engineering. S/he also supports the teams with necessary knowledge and skills for: research and data collection via surveys online, forming questionnaires, analysis of data, preparation of presentations with different software – PowerPoint, Prezi, Storyboardthat, videos, comix, digital storytelling and other tools. **Teacher 4 is in Math** and s/he also mentors a team of students who do research in the mathematical aspects of work of the entrepreneur/scientist/artist. S/he also teaches how to analyze data, use mathematics and statistics including preparation of the final presentations – e.g., analysis and diagrams, preparation of spreadsheets in MS Excel, etc. **Teacher 5 is in Arts** and provides mentorship and guidelines in terms of the aspects of arts.
Action Plan Formulation	**Stage 1** is preparatory actions by the teachers who work together led by the main teacher T1 who develops sample workplan with tasks, deadlines and topics aligned according to the curriculum of 10th grade. At this stage the assessment methodology is also developed – criteria and way of assessing students' work including self-assessment. Students are divided into teams and each one has a specific topic of STEAME to research and analyze. If here are two classes of 10th grade a different project is assigned – e.g., one for Leonardo da Vinci, one for Elon Musk, etc. **Stage 2** is the implementation when students start their work with introduction to the topics and all teachers work in their classes and online to mentor the students with specific questions. Throughout the classes students research and analyze different case studies, i.e. the work of the person (Leonardo da Vince, Elon Musk, etc.) and provide examples. **Stage 3** is **finalization** when all teams prepare their final presentations in the Computer science/IT classes and **Stage 4 is evaluation** of the work. Each teacher follows the aligned evaluation methodology, i.e. evaluates the teamwork, the research and knowledge, the presentation and communication skills of students.

under development the final elements of the framework

3. Objectives and Methodologies

Learning Goals and Objectives	Upon completion of the class students should **know**: - What the application of science in real work of certain successful person is - How important interdisciplinary approach is - How important teamwork is - What is project work and how to lead and implement it - Main terminology and key theoretical concepts in STEAME They should **be able to** - Work in teams and lead/follow the leader - Cooperate with their teachers in the relationship mentor-mentee - Conduct scientific research - Provide references - Analyze data and prepare diagrams, graphs, Excel tables, etc. - Prepare presentations and digital storytelling - Apply creativity and generate new ideas - Communicate in the team and in front of audience
Learning Outcomes and expected Results	Expected **results**: - Presentations with storytelling elements/videos/comix, etc. - Analysis and research results

	- Final conclusions - Real application of the topics taught in their science classes
Prior Knowledge and Prerequisites	Maths and IT – Excel, presentation skills with PowerPoint, work with MS office, research and analysis.
Motivation, Methodology, Strategies, Scaffolds	The main differentiator in this Plan is the new role of teachers T2-T5 who guide and support the student teams on their work. Other approaches applied in the process are project- and inquiry-based learning. Under the new conditions of Covid-19 it can be easily adapted and be implemented as blended learning with flipped learning elements. This is another innovative approach, used in the project which is a type of blended learning where students are introduced to content at home and practice working through it at school. This is the reverse of the more common practice of introducing new content at school, then assigning homework and/or project to be completed by the students independently at home[1]. The plan allows individual work by each student when doing their research and the team leader could divide the case study/topic into sub-topics for each team member, then team analysis and findings followed by preparation of the team presentations, videos, stories, etc. Thus it is a multi-modal approach and allows flexibility based on the student's learning style.

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[1] https://www.teachthought.com/learning/the-definition-of-the-flipped-classroom/

4. Preparation and Means

Preparation, Space Setting, *Troubleshooting Tips*	There is one leading Teacher 1 who is in Economics and Entrepreneurship field. T1 leads the process as the classes are organized around the STEAME projects aligned with the topics of studies in science, computer science/IT, Arts, Math. There are classes taught in the Labs – science, arts, IT ands students work there. All student teams should have at least one PC/laptop/desktop. In addition teachers provide also online support in the mentoring process according to a work plan.
Resources, Tools, Material, Attachments, Equipment	Tools to be used: - MS office – Word, Excel, PowerPoint, mind maps, analytical tools, - Citation Guide (https://libguides.dixie.edu/) - Digital storytelling: www.storyboardthat.com , www.powtoon.com , www.pixton.com, www.canva.com, etc. - Mind maps – www.miro.com, www.mindmup.com, www.mindmeister.com , venngage.com, etc. - communication and collaboration platform - Google Meet, Google Classroom, Zoom, Skype, etc. - e-learning platform – Google classroom
Safety and Health	

5. Implementation

Instructional Activities, Procedures, Reflections	This Plan is developed around the school classes from elective school subjects as the leading teacher/class. It covers: i. Information Technology ii. Entrepreneurship iii. Market economy (Economics) iv. Starting your own business v. Entrepreneurial management vi. Marketing vii. Finance viii. Presentation and communication skills The other teachers/subjects from the i. Teachers plan their activities on Google Calendar as part of the curriculum. T2-T5 follow their regular plans and includes examples and information and activities based on the main case study – e.g. the work of Leonardo da Vinci, Elon Musk, etc. Students are actively engaged through hands-on experience and research conducted as homework assignments which are then discussed in class. Each team has a mentor according to their assigned aspect/topic, i.e. *Technology and engineering in the work of Leonardo da Vinci, etc.* The planned **24 learning hours** are based on a class of 40 minutes. **The lead teacher, T1** is engaged in all his/her classes in one school year, i.e. 36 classes of 40 minutes each. - 4 hours introduction and preparation - followed by 12 hours – implementation - 4 classes work on presentations and video making - 4 hours final presentations and feedback sessions. T2-T5 align their activities with the implementation within 8 learning hours including 4 learning hours guidelines of T3-4 how to analyze data, develop diagrams/graphs and online surveys (Google forms, Survey monkey, etc.).

Assessment - Evaluation	**The evaluation** is done on the following scale: - Self-assessment by team members (reflects the degree of critical thinking of each team member): from 0 to 100%, depending on the % of the total result achieved as an individual contribution - Team assessment by the team leader and the teacher: (reflects the opinion of the team leader and the teacher about the work of each team member described in "Criteria for evaluating the individual and team contribution of the participants in STEAME and project-based training (points 1 to 9)": from 0 to 100%, depending on the% of each contribution to the overall team result - Teacher's assessment in the respective discipline: (assessment of performance - individual and team plus current assessment): from 0 to 100%, depending on the individual and team result - Jury rating (depending on the ranking): from 0 to 100% - Bonus assessment (set at the teacher's discretion: from 0 to 100%
Presentation - Reporting - Sharing	Case studies and the respective projects of students can be developed as follow: Case study **Leonardo da Vinci** - *Scientific research, engineering and technological inventions and ingenious achievements in the fine and graphic arts of Leonardo da Vinci* - *The Golden Ratio and Leonardo's* - *Paints now and then* - *Differences between Da Vinci's drawings and contemporary anatomy* Case study **Elon Musk** - *Science and technology behind the entrepreneurial success of Elon Musk* - *Elon Musk – the explorer and scientist* - *Arts and solar energy* - *The engineer Elon Musk*
Extensions - Other Information	

STEAME Prototype/Guide for Learning & Creativity Approach
Action Plan Formulation

Major steps in the STEAME learning approach:

STAGE I: Preparation by one or more teachers

1. Formulating initial thoughts on the thematic sectors/areas to be covered:
    a. Key success factors and traits of successful entrepreneurs, artists, scientists
    b. Research and analysis of data
    c. Presentation and communication skills, tools and methods
    d. Digital storytelling
    e. Preparation of online surveys and questionnaires
    f. Ethics of science
    g. Business development and growth
    h. Science, technology and engineering in business creation and development

2. Engaging the world of the wider environment / work / business / parents / society / environment/ ethics
    The project- and inquiry-based learning is organized around real case studies and best practices that are familiar to students – i.e. famous scientists, entrepreneurs, including local ones who can be involved in the process with interviews, brief presentations, discussions, participation and evaluation at the final presentations, etc.

3. Target Age Group of Students - Associating with the Official Curriculum - Setting Goals and Objectives
    The plan allows for involvement of students in Grades 8-12.

4. Organization of the tasks of the parties involved - Designation of Coordinator - Workplaces etc.
    T1 is the teacher in Entrepreneurship, Business, Economics areas. S/he provides the main case study/topic of work of the students and provides organizational guidance to the other teachers T2-T5 including strict workplan, tasks and monitoring. The classes can be done both online and in the classroom.
    T2 is teacher in Science – Biology, Chemistry, Physics – providing mentorship to one student team who work on the science aspects/sub-topics and provide knowledge about the specific examples, analysis of the work of the person assigned, including terminology and theory to be considered in the research; bibliography, citation rules and sources of credible information; guidance for analysis of data. Classes are conducted in the Science Lab.
    T3 is teacher in Computer science/IT fields who works closely with the **T4 in Mathematics**. They prepare students how to conduct research, analyze data, use Excel incl. formulas, diagrams/graphs, online surveys and questionnaires, etc. for statistical analysis and presentations. T3 and T4 conduct classes in the Computer lab.
    T5 is the teacher in Arts who provide mentoring and guidance related to the aspects of arts and the artistic, design and other related elements. T5's classes are in the Arts Lab.
    Teachers 2-5 have the main role of mentoring and they are engaged both in their regular classes in the classroom, and after class work – online via email and other**.** In the preparation stage they organize their classes and include interdisciplinary elements with particular examples, cases, exercises for homework and additional tasks for the teams.

STAGE II: Action Plan Formulation (Steps 1-18)

Preparation (by teachers)

1. **Relation to the Real World – Reflection**
   Students are engaged in a project to apply their knowledge and skills in the real world examples. It is always a good idea to apply role models, famous people/"rock stars" whose life and work are successful.
2. **Incentive – Motivation**
   Students work in teams of 4-5. According to the criteria they can compete for the first place. They receive additional recognition by the T1 and/or the school as Certificates, extra-curricular work they conduct, etc. This L&C Plan allows for organization of final competition among all teams and/or different classes.
3. **Formulation of a problem (possibly in stages or phases) resulting from the above**
   Defining the main case study can be defined either by the group of teachers 1-5 involved in this plan and/or by the students themselves. It is necessary to define criteria for selection – e.g., popularity, success, performance, innovative products/services, paintings, sculptures, interesting facts, etc. It needs to be interesting and appealing to students and their age. Students in general are more creative, they look for information online via different channels/platforms/media and can define the case study themselves, guided by their teachers. This however should be a well structured and guided process as they work in teams and the topic should allow division of sub-topics in Science, Technology, Engineering, Arts, Math, Entrepreneurship.

Development (by students) – Guidance & Evaluation (in 9-11, by teachers)

4. **Background Creation - Search / Gather Information**
   Students learn about the key success factors and concepts of work, incl. entrepreneurship and business creation. The main information is taught in class and then additional research is conducted online and via interviews (if and when possible). The role of all teachers and teach them how to find the credible sources, how to evaluate and analyze data, how to develop insights and drive final conclusions to develop presentations.
5. **Simplify the issue - Configure the problem with a limited number of requirements**
   After the initial definition of the case study and the main topic/best practice for the work of students each teacher defines more specific sub-topics which are then assigned to one team – thus there are at least six teams of 4-5 students within the following aspects/sub-topics:
   - Science
   - Technology
   - Engineering
   - Arts
   - Mathematics
   - Entrepreneurship

   The definition is broad enough to give freedom to students to develop their own research plan and main goals. The minimum requirements are related to the development of: online survey, desktop research, processing of the survey results, visualization of key findings and driving conclusions. All of the above is structured in a presentation.
6. **Case Making - Designing - identifying materials for building / development / creation**
   All student work in teams. T1 provides general guidance and introduction to the projects in the first 2-3 classes in subject Entrepreneurship. Teams are formed by students and mentored by teachers 2-5 who provide in-class and extracurricular distance support. All teams follow the same working process but in different sub-fields: preparation on the subject, initial desktop research, online survey, analysis of survey results, further research, preparation of a presentation and video.
7. **Construction - Workflow - Implementation of projects**
   During the implementation of projects students follow their action plans approved by the mentors and the main teacher T1. Each plan should include desktop research, collection and

analysis of responses to online survey, key conclusions and insights presented in final team presentations. The main content is developed within the sub-area defined at the introduction and preparatory stage.

8. **Observation-Experimentation - Initial Conclusions**
Student teams conduct small-scale experiments in their STEAME classes, together with exercises, examples and theory. Students observe the processes and main concepts, then generate their own research which includes desktop research and online surveys. Depending on the case study defined it may include also conducting focus groups with peers and partners as well as interviews. Final results are accumulated and visualized in a presentation and a video/story.

9. **Documentation - Searching Thematic Areas (STEAME fields) related to the subject under study – Explanation based on Existing Theories and / or Empirical Results**
Students and mentors work together to validate the findings of the research. The models that are used for data analysis and main findings for the final presentations are aligned with the studies in 10th grade. Most common tools are based on MS Excel with focus on visual representation and use of graphs. In terms of science, simple experiments and knowledge are applied so that students can draw conclusions for the application in real life and work related to the case study they are working on. The method of flipped classroom can be applied here as students work at home to review the theoretical content and then discuss in class and/or in their teams and ask relevant questions for further clarification and application in their projects.

10. **Gathering of results / information based on points 7, 8, 9**
The main challenge in gathering accurate results is the source of information and the target groups for the online questionnaires that are distributed mainly in the existing networks in social media of students and mentors. Part of the process is the credibility of the source for the desktop research, which is covered by all teachers and mainly the ones who teach science. They provide guidance and monitor the process – e.g., what is the average age, area of expertise, geographic area, gender, etc.

11. **First group presentation by students**
There are several presentations which mark the milestones in the work of the teams:
    o One for the findings of the desktop research
    o One based on the online surveys and the collection of answers, analysis and visualization.
    o Semi-final

Important part is the synthesis of all information and the ability to prepare graphs and comparisons – e.g. technologies and processes in the past and present days. Another important aspect is the impact on business development when working on case studies of entrepreneurs.

Configuration & Results (by students) – Guidance & Evaluation (by teachers)

12. **Configure mathematics or other STEAME models to describe / represent / illustrate the results**
Besides mathematical/statistical and scientific models, the presentations and analysis should include some financial analysis in terms of costs, revenue, profit and financial forecast. This is covered in the special subjects like Economics and Entrepreneurship which are usually taught at this level.

13. **Studying the results in 9 and drawing conclusions, using 12**
Students work actively in steps 4-9 but the role of mentors is critical for their argumentation, main conclusions and validity of results. The models that are applied should be relevant t their grade/age and experience. Main aspect of evaluation and success factor is their understanding for the real-life applications and practical use of the results. This is supported

by the videos that they should prepare which proves how they perceive the knowledge gained in class.

14. **Applications in Everyday Life - Suggestions for Developing 9 (Entrepreneurship - SIL Days)**
    The research of case studies of famous people can lead to direct application to other fields and businesses. Their projects can be leveraged and developed further in 11th grade with work with business owners, managers and employees who provide their cases to be solved. The role of T1 here is important. The challenge can be related to innovation of businesses – established or start-ups who need fresh look and ideas.

Review (by teachers)
15. **Review the problem and review it under more demanding conditions**
    The main findings of students are structured in sub-areas and specific topics that they should identify to find the main problem and then provide recommendations. Teachers act as mentors and monitor if and how the case study is analysed.

Project Completion (by students) – Guidance& Evaluation (by teachers)
16. **Repeat steps 5 through 11 with additional or new requirements as formulated in 15**

17. **Investigation - Case Studies - Expansion - New Theories - Testing New Conclusions**
    As described in step 14 the projects can be extended to draw conclusions and compare results with real companies and/or other organisations who agree to work with students on defined challenge to test new approaches and ideas, e.g. how the approaches of successful people/companies would affect their business.

18. **Presentation of Conclusions - Communication Tactics**
    The final presentations should consist of two main parts:
    o Presentation with key findings, recommendations and conclusions with graphs, images, etc.
    o Video telling a compelling story that complements the presentation and the
    o Preparation of tables, spreadsheets, graphs, etc. to represent analysis of answers from the online questionnaires.
    o Use of social media and e-learning platforms for communication with the teachers and in the teams.

STAGE III: STEAME Actions and Cooperation in Creative Projects for school students

Title of STEAME Project : _____
Brief Description/Outline of Organizational Arrangements / Responsibilities for Action

STAGE	Activities/Steps Teacher 1(T1) Cooperation with T2-T5 and student guidance	Activities /Steps By Students Age Group: 10th grade (16 years old)	Activities /Steps Teacher 2 (T2) Cooperation with T1 and student guidance
A	Preparation of steps 1,2,3		Cooperation in step 3
B	Guidance in step 9	4,5,6,7,8,9,10	Support guidance in step 9
C	Creative Evaluation	11	Creative Evaluation
D	Guidance	12	Guidance
E	Guidance	13 (9+12)	Guidance
F	Organization (SIL) STEAME in Life	14 Meeting with Business representatives	Organization (SIL) STEAME in Life

G	Preparation of step 15		Cooperation in step 15
H	Guidance	16 (repetition 5-11)	Support Guidance
I	Guidance	17	Support Guidance
K	Creative Evaluation	18	Creative Evaluation