



INTELLECTUAL OUTPUT 4

Behavioural Assessment Model (BAM)

Ln2steam



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PROJECT INFORMATION

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Introduction

IN2STEAM project aims to enhance, encourage and foster innovative educational approach that integrates STE(A)M learning (applying art and design principles to science education) in primary education through gender-inclusive methods and resources to promote a positive change of attitudes towards non–stereotyping choices in education in order to attract more girls into STEM fields.

As part of IN2STEAM pedagogical approach, four main results were developed (2 already finalized and other 2 currently being developed):

1. IO1 – REPORT ON THE VALUE OF STE(A)M IN GIRLS' EDUCATION
2. IO2 – ONLINE TRAINING CURRICULUM IN STE(A)M LEARNING AND GENDER SENSITIVE PRACTICES
3. IO3 – DIGITAL TEACHER'S TOOLKIT (DTT) WITH STE(A)M ACTIVITY KIT FOR PRIMARY SCHOOL
4. IO4 – EUROPEAN CHARTER AND IMPACT REPORT

The current document is one essential part of the project forth result and consists in a Behavioural Assessment Model (BAM) to assess & monitor acquisition of key competences in STE(A)M as well as the impact on learning process of young girls related to STE(A)M concepts and their behaviour change including students learning, attitudes and behaviour.

As such, the present work will detail all characteristics of such model, including information about a set of assessment tools to be used by teachers within the classroom and instructions on how to do it.

1. The Model Definition

1.1 STE(A)M SKILLS

The core feature of STE(A)M is the use of science, mathematics, technology, engineering and arts knowledge to solve daily or societal problems, making the learning of science, technology, engineering and mathematics more meaningful and contextual.

According to Bybee (2013), STE(A)M literacy has been defined as:

- Knowledge, attitudes, skills, and values to identify questions and problems in life situations. Explain the natural and designed world, and draw evidence-based conclusions about STE(A)M related issues;
- Understanding of the characteristic features of STE(A)M disciplines as forms of human knowledge, inquiry, and design;
- Awareness of how STE(A)M disciplines shape our material, intellectual, and cultural environments; and
- Willingness to engage in STE(A)M-related issues with the ideas of science, technology, engineering, and mathematics as a constructive, concerned and reflective citizen.

There is, currently, limited research into the prerequisite knowledge, skills, attitudes, values and experiences that are a necessary part of a competency-based curriculum and also limited consideration of the challenges that teachers face in implementing a competency-based curriculum effectively. This is especially true for Science, Technology, Engineering, and Mathematics education, since the concept of STE(A)M as a connected, and potentially integrated, field of study, is relatively new. Accordingly, there is an increasing need for an integrated STE(A)M framework to assist teachers, trainers and curriculum developers to meet the demands for effective 21st century STE(A)M education.

As such, IN2STEAM project intends to develop a model, in specific, a Behavioral Change Model (BAM) that will allow teachers to better assess their students' progress in what regards their attitudes and behaviors related to STE(A)M. IN2STEAM BAM will have as fundamental cornerstone the following STE(A)M skills concept:

- **STE(A)M skills:** *Skills required in carrying out STEM-related tasks include cognitive, manipulative, technological skills and collaboration and communication skills. However, as Industrial 4.0 advances, both STE(A)M and non-STE(A)M tasks are in dire need of young people who have developed/are developing and can apply the broad skill-set. In light of the rapid rate of progress in the STEM fields, all learners need to be engaged in continuing professional development or continuous enhancement of such competencies (Boon, 2019).*

INT2STEAM project proposes a STE(A)M competences model assessment based on cognitive skills, as well as social and emotional skills which will allow to properly assess the competences developed by students during the IO3 activities. These skills were already partially mapped within the proposal stage and are further detailed in this document.

Cognitive skills

Cognition refers to the mental process of understanding through thinking and experiences. The range of cognitive skills needed include: information management and processing, (identifying, collecting, processing and using relevant data to make decisions) critical, creative and analytical thinking, problem solving skills, scientific investigation, creativity and computational thinking. These skills are not mutually exclusive. For the BAM model, the following skills were identified as most relevant for the age group 8-11 years old:

- Problem solving.
- Critical Thinking.
- Creative Thinking.
- Entrepreneurship.
- Media Literacy.
- Tech Literacy.

Social and emotional skills

Communication skills, as well as self-confidence, self-awareness, and interpersonal skills do not always occur naturally and need to be explicitly developed, as most tasks are complex and interrelated, and cannot be achieved by a single person's effort but, rather, through effective teamwork.

Having as core aspect of its pedagogical approach gender equality focused on the unrepresentativeness of women in STEM fields, the IN2STEAM BAM will focus on the assessment of self-confidence and self-awareness as key focal skills that were thoroughly explored within the project IO2 as being part of the factors that influence gender participation in STEM. IN2STEAM will thus include the following social and emotional skills:

- Self-confidence.
- Self-awareness.
- Interpersonal skills.
- Communication skills.

Table 1- BAM skills description

	SKILL	DESCRIPTION
COGNITIVE SKILLS	Problem solving	Allow children to solve problems by themselves, so they can become confident, independent, and successful individuals, manage their emotions, think creatively, and persist until they find a solution.
	Critical Thinking	The ability to think clearly and rationally, understanding the logical connection between ideas. Kids become better learners and critics when they are forced to explain how they solve problems.
	Creative Thinking	Think about an activity, homework or a problem in a new or different way or use the imagination to generate new ideas.
	Entrepreneurship	The practical application of enterprising qualities, such as initiative, innovation, creativity, and risk-taking into the classroom environment.

	Media Literacy	The ability to identify different types of media and understand the messages they're sending.
	Tech Literacy	The ability to assess, acquire and communicate information in a fully digital environment. Know, understand and make personalized use of different technologies.
SOCIAL AND EMOTIONAL SKILLS	Self-confidence	It means to accept and trust yourself and have a sense of control over your life. To know one's strengths and weaknesses well and have a positive outlook on the self. To set realistic expectations and goals, communicate assertively and be able handle criticism.
	Self-awareness	Ability to understand, manage and reflect own emotions, strengths, belief systems, limitations and potentials.
	Interpersonal skills	The ability to communicate and build relationships with others (i.e. active listening, teamwork, responsibility, leadership, motivation, flexibility, patience, empathy, ability to work with others to achieve a common goal etc).
	Communication skills	Ability to interact with others in several contexts, to exchange information, ideas, knowledge in a mutual understanding; Ability to present information in a clear and effective way.

IN2STEAM developed a series of lesson plans to be used by teachers during classes, most precisely during STE(A)M LABs. These lesson plans are aligned with the BAM skills, and thus specific lesson plans will allow the development of a certain set of skills.

Below, the correlation table allows an easy match of the cognitive skills with the corresponding lesson plan. Entrepreneurship and Media Literacy have only one lesson plan each. Teachers can go the extra mile and include entrepreneurial features and/or media literacy aspects within other lesson plans, in case they wish (example: in any given lesson plan, teachers can ask students to research on online reliable media about the subject they working on, thus encouraging media literacy development).

Table 2 - Correlation with Lesson plans

	SKILL	LESSON PLAN
COGNITIVE SKILLS	Problem solving	Calories Count; Carbonated Drinks; Corrosion; Create your stemlab; DNA extraction; Geometric Robot; The green tablet; How to see the sound; Making Predictions; Mondrian's Fractions; Mosaics; My own vehicle; Neverending mirror; our own hovercraft; Recognise the Matter; Science Buffet; The robotic hand.
	Critical Thinking	Auroras Borealis; Calories Count; Connecting bridges; Corrosion; Create your stemlab; Geometric Robot; How to see the sound; Inquisitive insects; Making Predictions; Mondrian's Fractions; My own vehicle; Neverending mirror; our own hovercraft; Recognise the Matter; Science Buffet; The water travels.
	Creative Thinking	Auroras Borealis; Calories Count; Connecting bridges; Create your stemlab; Geometric Robot; Geometric Shapes; The green tablet; How to see the sound; Inquisitive insects; Mondrian's Fractions; Mosaics; My own vehicle; our own hovercraft; The water travels.
	Entrepreneurship	Connecting bridges.
	Media Literacy	Geometric Robot.
	Tech Literacy	Create your stemlab; DNA extraction; The green tablet; How to see the sound; Mosaics; My own vehicle.

NB. The social and emotional skills are not featured in the above table because they are generally developed within any lesson plan. As such, teachers should closely analyze such skills development during the activities.

1.2 STE(A)M SKILLS LEVEL FRAMEWORK

For each STE(A)M skill identified, a scale of three descriptive levels was defined to support the monitoring and assessment of each skill during the STE(A)M LABs: Excellent; Intermediate; Basic.

This table should be analyzed and used by teachers and STE(A)M professionals while assessing the students' performance during each activity. Some remarks should be done by teachers in their Teachers Diary highlighting the main achievements.

Table 3 - Skills Level Description

Skills	Excellent	Intermediate	Basic
Problem solving	<p>Has the ability to generate solutions to a range of STEM-based problems and scenarios, including organizing ideas, defining goals and milestones, and executing plans.</p> <p>Uses a range of approaches to problem solving, including the scientific method and design thinking.</p>	<p>Has the ability to generate a single solution to a range of STEM-based problems and scenarios, including organizing ideas, defining goals and milestones and executing goals and milestones, and executing plans.</p>	<p>Led through activities step by step.</p> <p>Teachers may model problem-solving skills, but students do not engage with these skills.</p>
Critical Thinking	<p>Evaluates sources of information, evidence, and primary materials; Critiques the work of others;</p> <p>Uses evidence to build an argument.</p> <p>Makes predictions based on given information and form conclusions or generalizations about phenomena.</p>	<p>Reviews primary materials or sources that allow them to evaluate and integrate new knowledge.</p> <p>Makes predictions based on given information (if X, then Y), but is not able to generalize or test hypotheses.</p>	<p>Does not evaluate information or evidence presented; Information is imparted from a unitary perspective.</p> <p>Doesn't make predictions, test hypotheses, or build arguments.</p>
Creative Thinking	<p>Approaches problems from different perspectives and can generate and adopt novel, innovative approaches.</p> <p>Synthesizes of activity outcomes and reflection on the value of novel and innovative approaches and solutions.</p>	<p>Does not approach problems from different perspectives, however, does develop work products (e.g., explanations, representations, presentations) that express their perspectives or approaches.</p>	<p>Does not approach problems from different perspectives.</p>

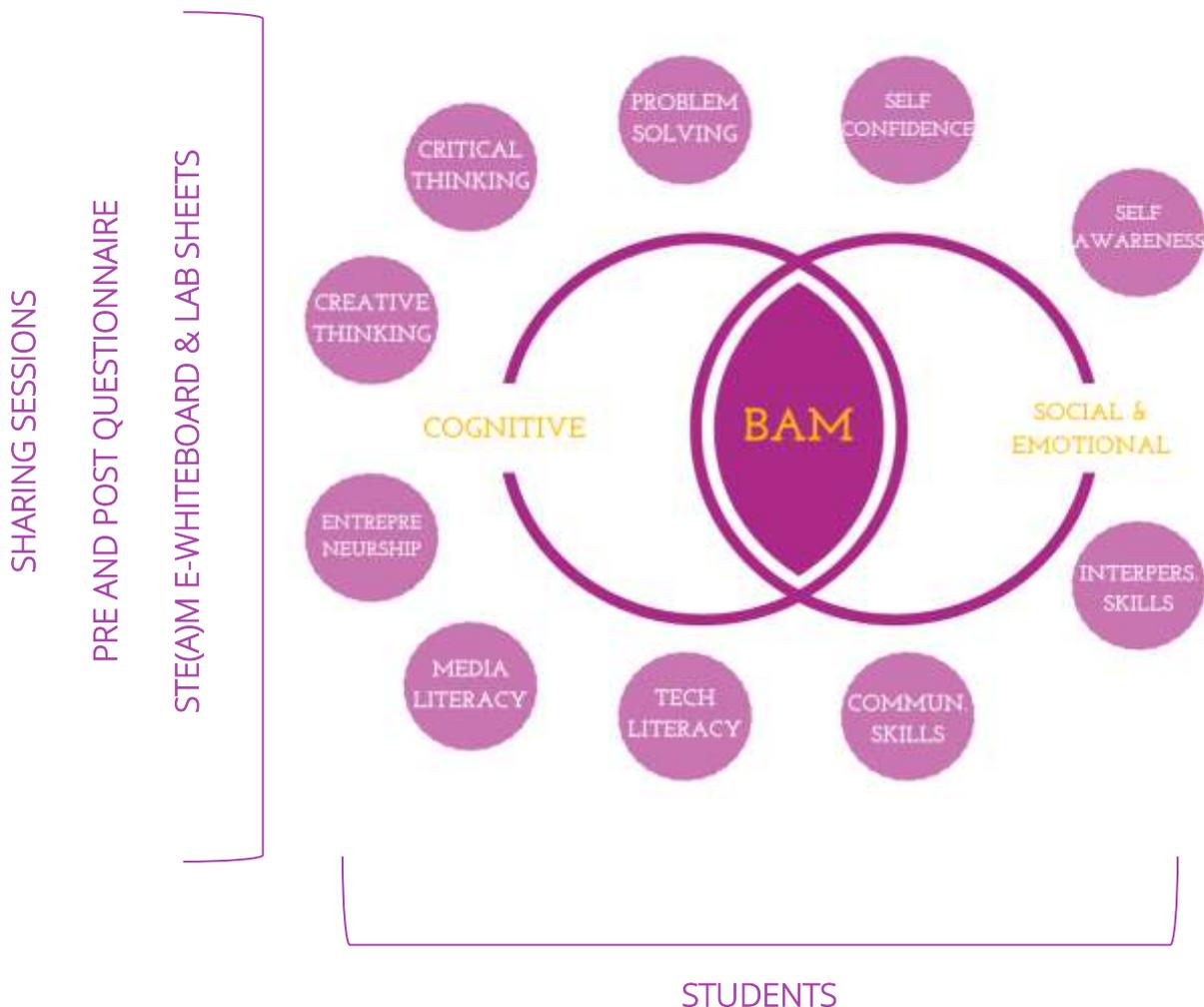
	Makes explanations, representations, presentations) that express their perspectives or approaches to activities.		
Entrepreneurship	Is able to take risks and make decisions. Does not fear failure	Communicates within the team, taking into account the diversity of opinions.	Student is self-motivated and energetic. Student is an optimistic thinker and does not give up at the first hurdle.
Media Literacy	Make judgements about the quality or the value of a media content.	Examines the structure, content, design, form and sequence of the messages with a critical perspective. Perceives the implicit meaning as well as the explicit meaning in the messages.	Locating and using appropriate media tools, reaching the targeted information via these tools, and comprehending the meanings of the contents.
Tech Literacy	Effectively uses technologies capabilities. Appropriately uses the different technologies.	Explores and attempts to use different applications of different technologies	Knows about new/different technologies. Understands new technology capabilities;
Self-confidence	Has ability to believe he/she can reach/achieve a goal.	Recognizes weaknesses and strengths.	Recognizes weaknesses.
Self-awareness	Identifies and analyses one's emotions, and how they affect others.	Is aware of the "self, student perception of self matches reality.	Is able to recognize and identify emotions.
Interpersonal skills	Is able to actively listen to others. Is able to be patient and flexible with others. Is able to build empathic relations with others.	Is able to communicate and build relationships with others showcasing teamwork, and motivation.	Does not reject the idea of working in groups.

			Showcases responsibility in doing the tasks assigned within a group.
Communication skills	<p>Communicates clearly, accurately, and/or persuasively about STEAM topics.</p> <p>Addresses multiple audiences.</p> <p>Uses multi-modal methods, such as drawings, images, visual representations, and models, to convey ideas.</p>	<p>Communicates clearly, accurately, and/or persuasively about STEAM topics.</p> <p>Uses multi-modal methods, such as drawings, images, visual representations, and models, to convey ideas.</p>	<p>Does not communicate clearly, accurately, and/or persuasively about STEAM topics.</p> <p>Uses multi-modal methods, such as drawings, images, visual representations, and models, to convey ideas.</p>

1.3 THE BAM VISUAL REPRESENTATION

The IN2STEAM Behaviour Assessment Model depicts 10 equally relevant skills which are going to be assessed by the teachers, STE(A)M professionals during a period of 3 months. The visual representations highlight both the skills and the tools to be used by teachers and the partnership to effectively assess students’ progress in regard to STE(A)M competences.

Figure 1 - Visual Representation of IN2STEAM BAM



2. TOOLS FOR STUDENTS' EVALUATION

A series of tools which will support the BAM deployment will be available for teachers. These tools will allow teachers to keep track of students' progress and thus facilitate the assessment of their competences:

- Two sharing sessions with one questionnaire deployment each.
- A Teachers' Diary.
- A Students STE(A)M collaborative online whiteboard & students LAB sheet.

2.1 SHARING SESSIONS

The BAM foresees two sharing sessions: one at the beginning of the STEM LABs implementation and one at the end.

First Sharing Session

Teachers will organize together with project partners a sharing session with their students to inform them how the IO3+IO4 implementation is going to happen. This session will thus introduce the students to the STE(A)M Labs but also to the start of the first activities foreseen in the BAM.

Teachers sharing activity with the class should set the scene in terms of STE(A)M. This sharing session includes discussion about STE(A)M concept and what it is/explore students' previous knowledge about STE(A)M; Interest in STE(A)M; and Motivation to start the STE(A)M LABS.

In this session students should answer a simple questionnaire that helps (us) set the scene as well. The questionnaire will, above all, help both teachers and partners understand students' level of awareness, interest and motivation for STE(A)M issues.

This questionnaire should be answered again at the end of the implementation (questionnaire available in annex 1), allowing thus to compare the changes that occurred in terms of students' awareness, interest and motivation for STE(A)M and understand part of the STEM LABs impact on students.

Second Sharing Session

A final sharing session will take place in December. During this last session, teachers together with project partners, students and (if possible) parents, will discuss the outcomes of the STEM LABs implementation and provide feedback, as well as analyze achievements, positive and negative points. Students will once again be asked to fill in the post questionnaire (questionnaire available in *Annex 1*).

The sharing sessions should ideally take from 30 to 40 minutes, but teachers are free to decide otherwise, according to what fits best their classroom context.

2.2 TEACHER'S DIARY

A teacher diary consisting of individual sheets per activity is available to support teachers and also STE(A)M professionals while collecting information about students' progress within each activity. The template is available in *Annex 2*.

2.3 STE(A)M ONLINE WHITEBOARD & STUDENTS LAB SHEET

During the STE(A)M LAB activities, students should collaboratively create a STE(A)M collaborative online whiteboard which will be done digitally using Padlet: <https://padlet.com/mariarodriguesdemacedo/m4qrql13xxxvdtci>

A collaborative online board per class involved in the STEM LABs should be created and be available in the national language¹.

There will be an entry per each activity, to which students should upload a register of the tasks/steps they did in order to complete the activity: photograph all the stages of the development of their activity and upload the pictures here and upload their STE(A)M activity sheet as well. Texts, documents and PPT presentations done within the context of the activity can also be uploaded.

¹ INOVA+ will support all teachers and/or partners in creating such boards, if needed.

As support to this collaborative online whiteboard development, all students should make use of their LAB sheet to register the most relevant thoughts, ideas and steps (LAB sheet available in *Annex 3*).

In case a given class cannot ensure students participation on the whiteboard, teachers can use a cardboard or a poster to still allow students to collaboratively register their work.

3. BAM DEPLOYMENT

The BAM deployment will be aligned with the STEM LABs implementation, and should generally follow the below timeline (however, there is flexibility in this pre-defined schedule, activities can start later on and/or finish earlier, depending on the schools' year calendar). Despite the possible differences regarding the schedule, it is necessary that the STEM LABs and the BAM implementation are done simultaneously.

September 2021	October 2021	November 2021	December 2021
<i>Lesson plans/STEM LABs implementation</i>			
<i>Teachers diary</i>			
<i>Students STE(A)M collaborative online whiteboard and LAB Sheets</i>			
Sharing session 1			Sharing session 2
Pre questionnaire			Post questionnaire

Annex 1 - Pre/post students' questionnaire

1. What is your name? _____

2. What is your gender? _____

3. How old are you? _____

4. How much do you like:

Science	😊 😐 😞	Arts	😊 😐 😞
Maths	😊 😐 😞	Technology	😊 😐 😞

😊 = Very much

😐 = Just a little

😞 = Not much

5. What would you like to study/know more about when you are older?

6. Do you like to do science activities outside school (for example: build a kite, go on nature walks, visit a science museum)?



7. Do you like to do mathematics activities outside school (for example: build a kite, go on nature walks, program a game, visit a science museum)?



8. Do you like to solve problems/challenges?



9. Do you like to know why things happen?



10. Do you like to be creative and imagine new stories, drawings and ideas?



11. Do you like to try new experiences?



12. Do you read/listen to news in the newspapers or on tv/internet?



13. Do you like to work/do your homework on the computer?



14. How do you feel if you do not perform well in a test?



15. Do you like to work in groups?



16. Do you like to make presentations?



17. Do you think the below subjects are difficult?

Science		Arts	
Maths		Technology	

– Easy

– A Little difficult

- Very difficult

18. Do you think the below subjects are exciting?

Science		Arts	
Maths		Technology	

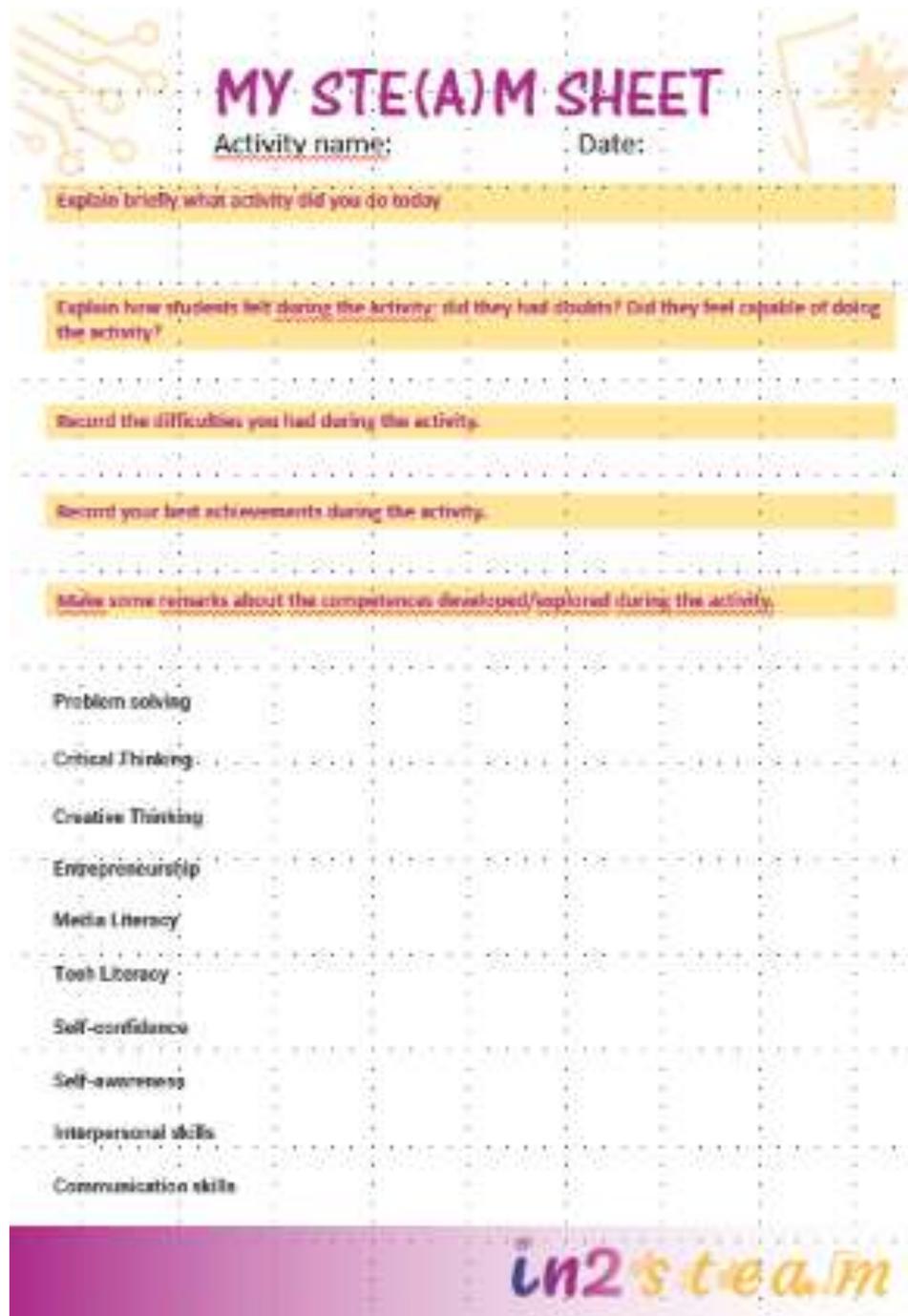
– Very exciting

– Just a Little exciting

- Boring

19. What do you want to be when you grow up? _____

Annex 2 - Teachers' Diary



The form is titled "MY STE(A)M SHEET" and is designed for teachers to record their activities. It features a grid layout with a light blue background and dashed lines. The title is in a large, bold, purple font. Below the title, there are two fields: "Activity name:" and "Date:". The form is divided into several sections by horizontal yellow bars with red text. The first section asks for a brief description of the activity. The second section asks for student feedback. The third section asks for difficulties. The fourth section asks for achievements. The fifth section asks for remarks on competences. Below these sections is a table with a list of competences on the left and a grid for recording data. The competences listed are: Problem solving, Critical Thinking, Creative Thinking, Entrepreneurship, Media Literacy, Tech Literacy, Self-confidence, Self-awareness, Interpersonal skills, and Communication skills. The form ends with the in2steam logo in a purple box.

MY STE(A)M SHEET

Activity name: _____ Date: _____

Explain briefly what activity did you do today

Explain how students felt during the activity: did they had doubts? Did they feel capable of doing the activity?

Record the difficulties you had during the activity.

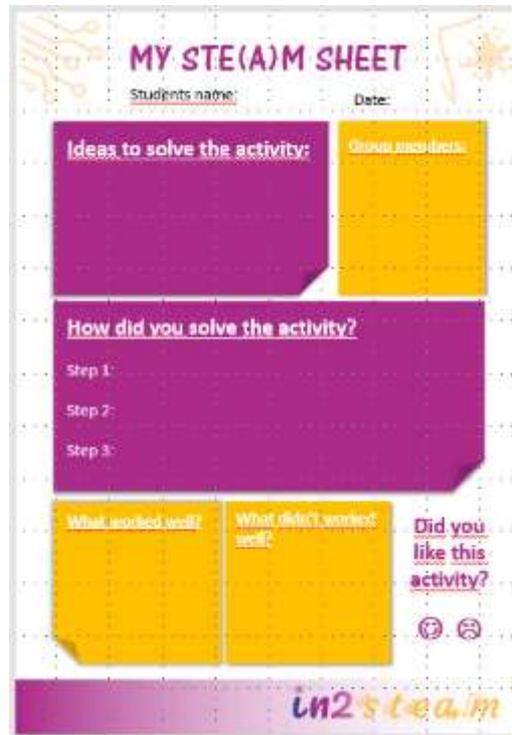
Record your best achievements during the activity.

Make some remarks about the competences developed/explored during the activity.

Problem solving				
Critical Thinking				
Creative Thinking				
Entrepreneurship				
Media Literacy				
Tech Literacy				
Self-confidence				
Self-awareness				
Interpersonal skills				
Communication skills				

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Annex 3 - Students' LAB sheet



MY STE(A)M SHEET

Students name: _____ Date: _____

Ideas to solve the activity:

Group members:

How did you solve the activity?

Step 1: _____

Step 2: _____

Step 3: _____

What worked well?

What didn't work well?

Did you like this activity?

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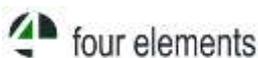
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