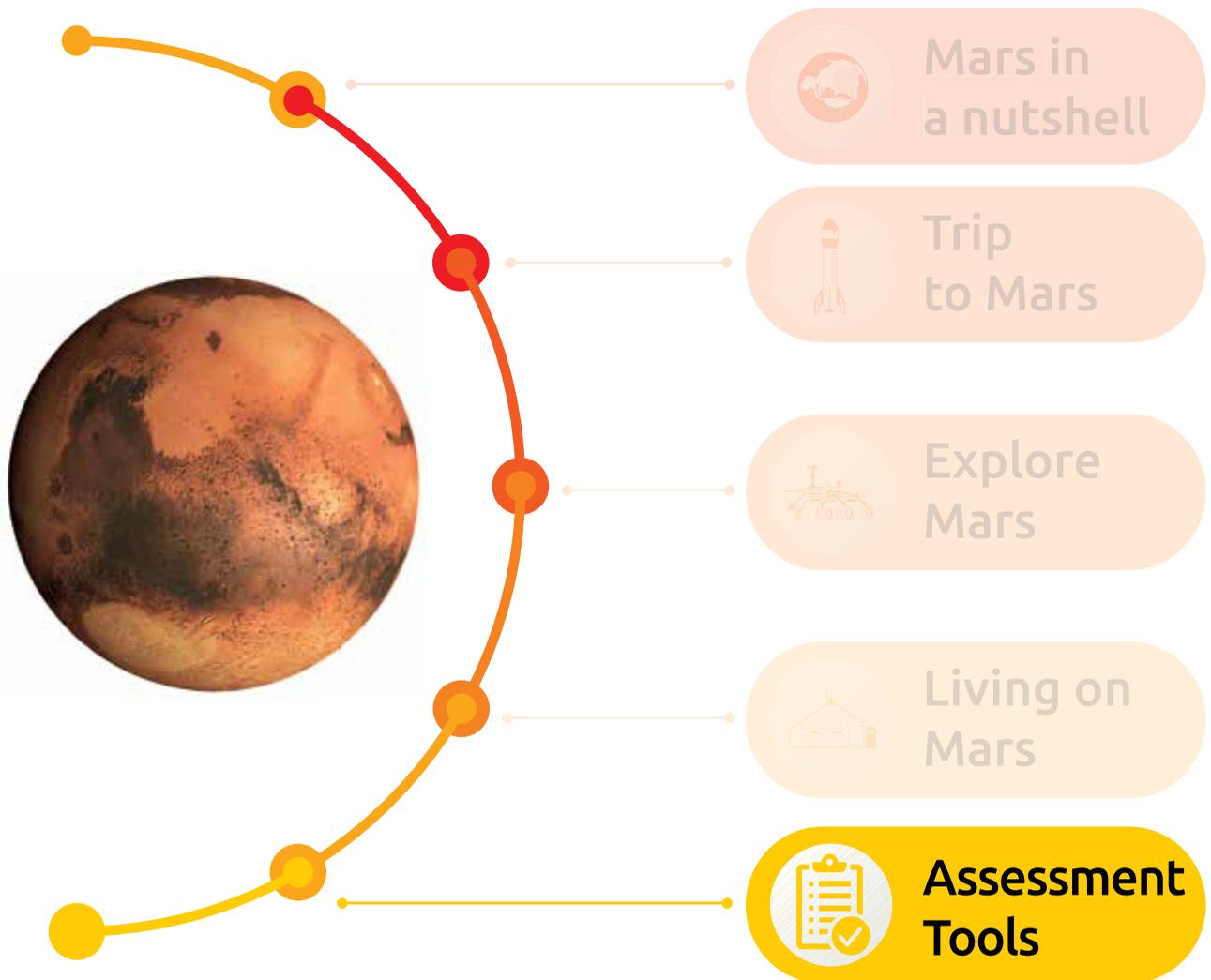


# STORIES OF TOMORROW

Students Visions on the Future of Space Exploration



Design by



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**Assessment  
Tools**



SCIENTIFIC ODYSSEY

# JOURNEY to MARS



FROM	NAME
Earth	
TO	DATE
Mars	2025



**Important:** Lorem ipsum dolor sit amet, nam aliquam probatus comprehensam an, per quem graeco evertitur te. Illum posse an sea.



COLONIZATION  
PROGRAM

No. 520015	
FROM	NAME
TO	DEPARTURE DATE

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ADMIT ONE

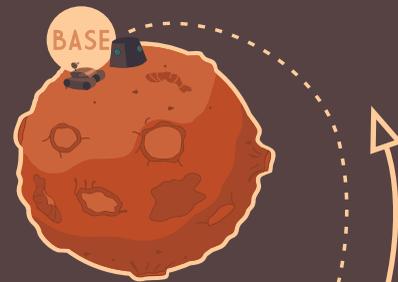


**MARS**  
ONE

BOARDING PASS

KEEP THE TICKET UNTIL THE END OF TRIP

ROADMAP



THE DISTANCE  
FROM EARTH  
TO MARS

34-60  
MILLION MILES

6-8  
MONTHS  
OF FLIGHT

TOP SPEED  
17 500 MILES  
(28 000 KILOMETERS)  
PER HOUR



*Have a pleasant trip*

*We glad to  
have you*  
**ABOARD!**

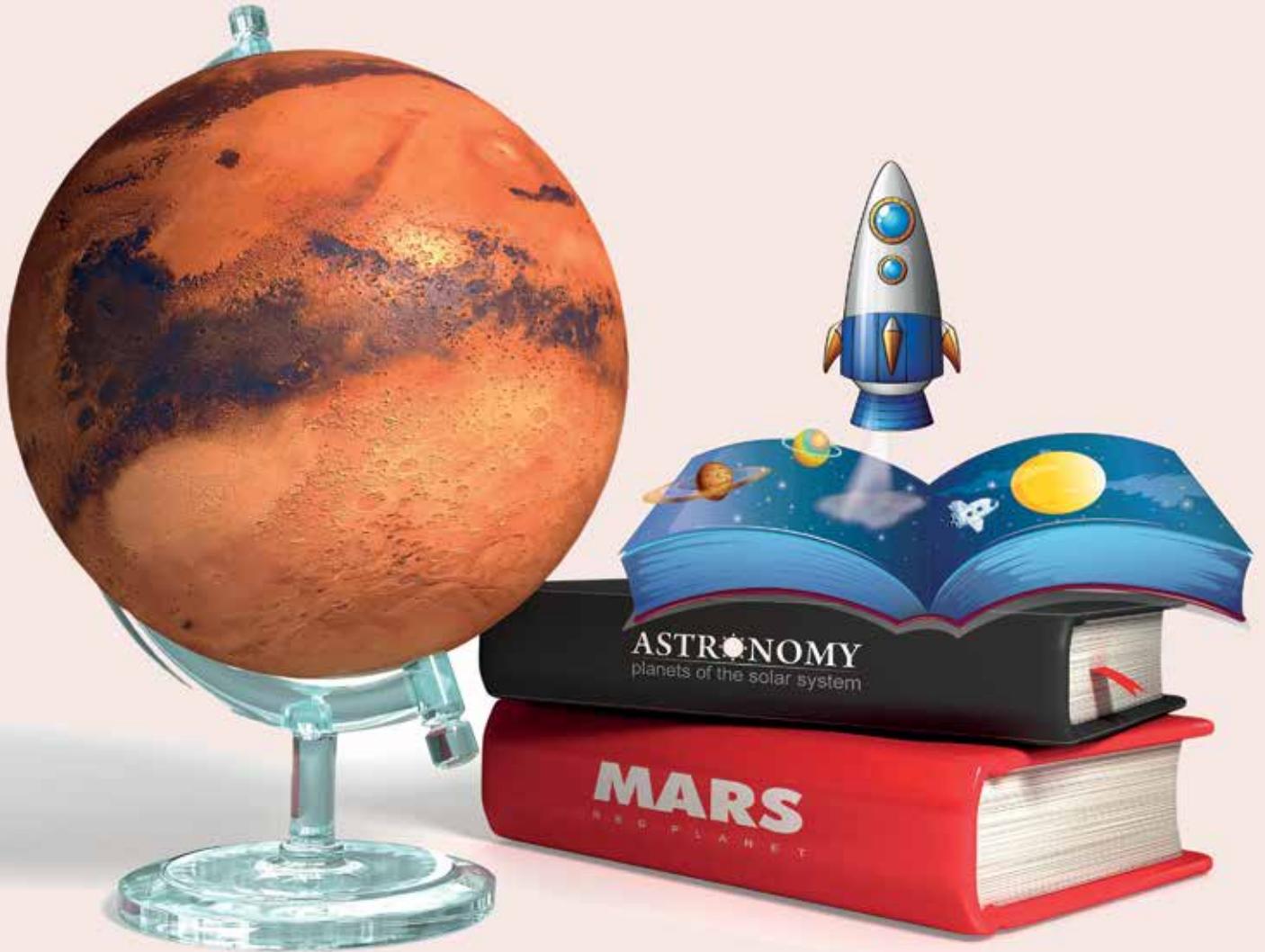


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BOARDING PASS

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## The STORIES Evaluation Approach

‘STORIES of tomorrow’ is the first research project to fully implement and empirically test the effectiveness of deeper learning in promoting STEM-mastery. Therefore, the STORIES Evaluation Approach plays an important part in the project.

To meet this aspiration, we designed a promising evaluation plan to compare students’ deeper learning competencies before and after the pilot phases. System data and classroom data such as time spent on the storytelling platform, questions posed to the teacher etc. obtained during the pilot phases will also be taken into account.

### Evaluation plan

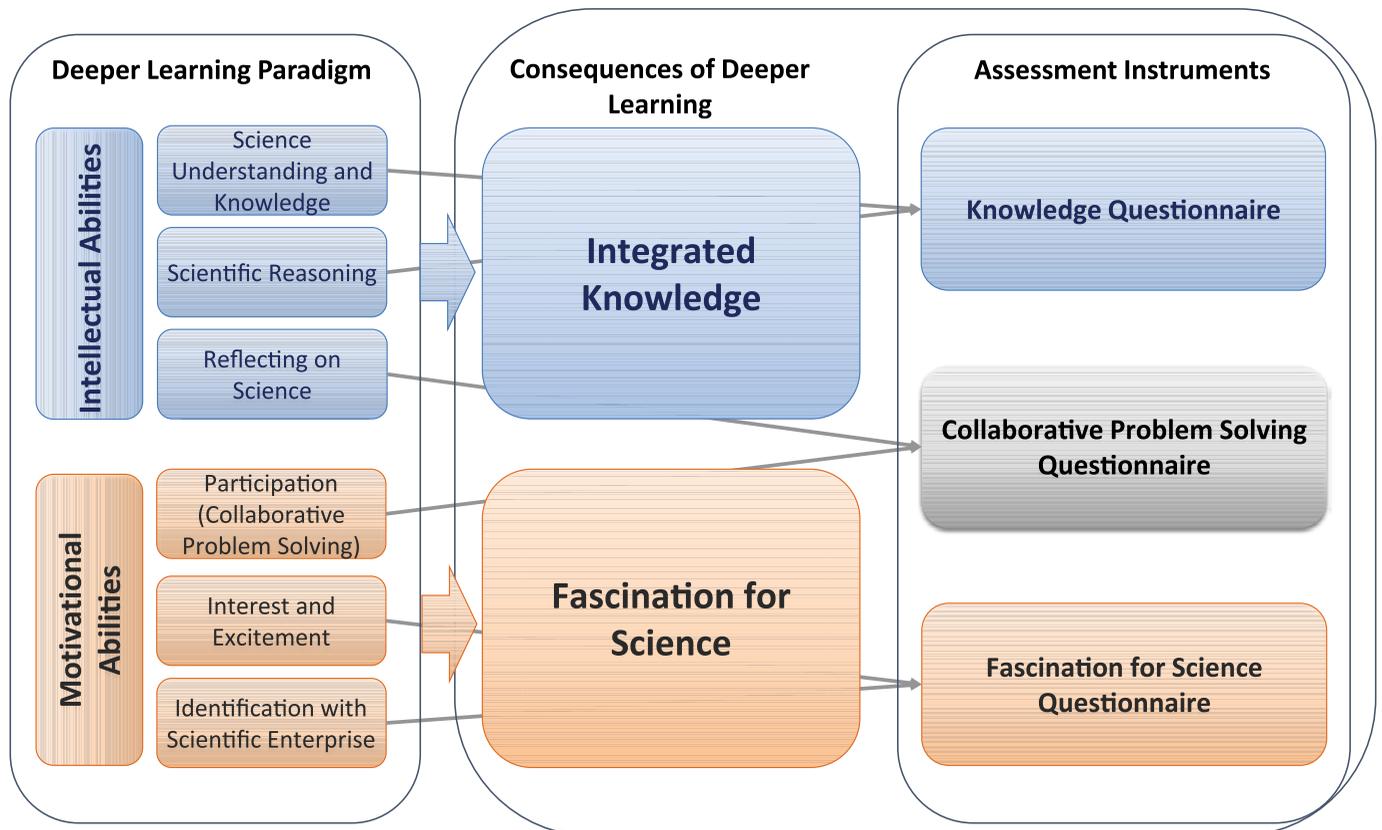


Figure 1. Measuring Deeper Learning by its consequences.



We will evaluate the STORIES program during the pilot phases by following a pre-test post-test design. Assessing prior to any intervention (baseline) by applying the same instruments as afterwards is a crucial prerequisite to answer the question, if students improved their deeper learning abilities. For that matter, we will set three time slots (one for each instrument described below) before and after the intervention.

During the intervention phases, we will collect system and classroom data such as time spent on the platform, number of interactions with experts, evaluation of the stories by the teachers etc. to check the accuracy of the intervention and to get useful information to explore the mechanisms behind deeper learning.

Based on the derived insights by the assessment of pilot phase A improvements for pilot phase B can be deduced. In general, advice as how to implement and improve deeper learning in STEM will be made. The developed assessment instruments will be refined and provided in a ready to apply form for other researchers and practitioners.

### ***Assessment instruments***

Students' deeper learning competencies will be surveyed by measuring their consequence: Fascination for science and integrated knowledge (see Figure 1). Therefore, we developed three assessment instruments. While integrated knowledge is assessed with knowledge questions that address knowledge itself, its application and reasoning, fascination for science is assessed with an according questionnaire. Additionally, we assess students' collaborative problem-solving abilities which mirror the two deeper learning competencies reflecting on science and participation that are highly interdependent in their consequences (integrated knowledge and fascination; see Figure 1).

### ***Measuring Integrated Knowledge***

To assess integrated knowledge, we draw on TIMSS (Trends in International Mathematics and Science Study) choosing items relating to the content of STORIES in the fields of earth science, physical science and life science. The questionnaire's tasks are categorized in three cognitive domains which correspond to the two intellectual abilities of the deeper learning paradigm in STEM to be measured: Knowing, applying, and reasoning.

Those cognitive domains define the type of behavior students engage in elaborating the question's content. "The first domain, knowing, covers the facts, concepts, and procedures students need to know, while the second, applying, focuses on the ability of students to apply knowledge and conceptual understanding to solve problems or answer questions. The third domain, reasoning, goes beyond the solution of routine problems to encompass unfamiliar situations, complex contexts, and multistep problems" (Mullis, Martin, Ruddock, O'Sullivan, & Preuschoff, 2011).

### ***Measuring Fascination for Science***

To capture Fascination for Science which reflects the motivational abilities Interest and Excitement together with Identification with Scientific Enterprise we use a new scale. To cover the psychologically relevant attitude components emotions, cognitions and behaviors (Eagly & Chaiken, 1993) we relied on existing educational research and added some new items to evenly serve every component. Students are asked about their feelings about Science, their out of school experiences and their thoughts about science. The more difficult statements students agree on and behaviors they engage in, like opening a device (radio, watch, computer, telephone, etc.) to find out how it works the higher we evaluate their fascination for science.

### ***Measuring Collaborative Problem Solving***

The deeper learning in STEM abilities Reflecting on Science (intellectual) and Participation (motivational) manifest in Collaborative Problem-Solving competency (see Figure 1) which can be defined as “the capacity of an individual to effectively engage in a process whereby two or more agents attempt to solve a problem by sharing the understanding and effort required to come to a solution and pooling their knowledge, skills and efforts to reach that solution” (PISA, 2013). For the assessment of collaborative problem solving in the first piloting phase, we developed a standardized self-report scale based on the different collaborative problem solving skills stated by PISA (2013) like discovering perspectives and abilities of team members or monitoring results of actions and evaluating success in solving the problem.

### ***References***

- Mullis, I. V. S., Martin, M. O., Ruddock, G. J., O’Sullivan, C. Y., & Preuschoff, C. (2011). TIMSS 2011 Assessment Frameworks. Boston: TIMSS & PIRLS International Study Center Lynch School of Education.
- Eagly, A. H., & Chaiken, S. (1993). The psychology of attitudes. New York: Harcourt Brace Jovanovich College Publishers.
- PISA. (2013). PISA 2015: Draft collaborative problem solving framework. Retrieved from <https://www.oecd.org/pisa/pisaproducts/Draft%20PISA%202015%20Collaborative%20Problem%20Solving%20Framework%20.pdf>



### ✚ DEEPER LEARNING

Introduce a profiling process for students' Deeper Learning competences through the development of objective and standardized student assessment instruments.



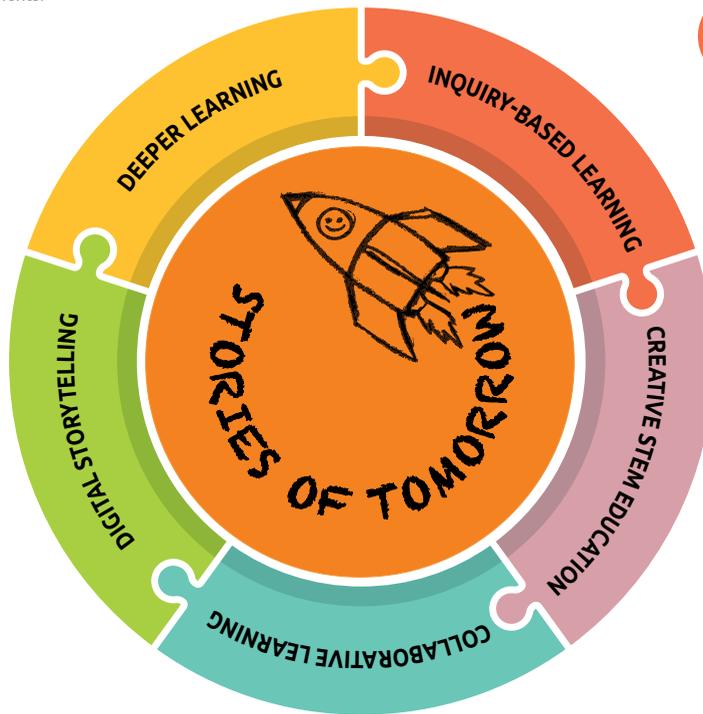
### ✚ INQUIRY-BASED LEARNING

Involve students in constructing their own knowledge based on personal experiences and explorations.



### ✚ DIGITAL STORYTELLING

Facilitating the convergence of student engagement, reflection for deeper learning, project based learning, and the effective integration of technology into instruction.



### ✚ CREATIVE STEM EDUCATION

Integration of Arts into STEM activities, simulating the ways in which subjects naturally connect in the real world.



### ✚ COLLABORATIVE LEARNING

Developing activities that are focused around placing the learner at the center, emphasizing interaction and doing, working in groups, and developing solutions to real-world problems in the framework of the stories' creation.



## Criteria for the assessment of stories by teachers

In order to monitor and follow students' progress throughout the implementation of activities related to Stories, we will collect different data (from the teachers and the platform) and will perform a number of actions using various tools to assess students' deeper learning.

Besides this type of assessment (described in the previous section) all students stories produced during the implementation phase will also be assessed by the participating teachers (in this type of evaluation components of storytelling are also taken into account). It is the overall outcome of assessment that will lead to the creation of the Students Deeper Learning profile.

Thus, considering the generation of criteria that will be used by teachers in order to assess in a uniform way the developed stories, the consortium has proposed some that are connected to the STORIES Pedagogical framework (including the essential features of Creativity, Storytelling and Deeper Learning).

Taking into account the Essential Features of Creativity, Storytelling as catalyst in the STEM-Art interaction, and the Deeper Learning competencies (as defined by Hewlett Foundation) the working group of experts outlined a set of criteria upon which the assessment of the students' stories will be based.

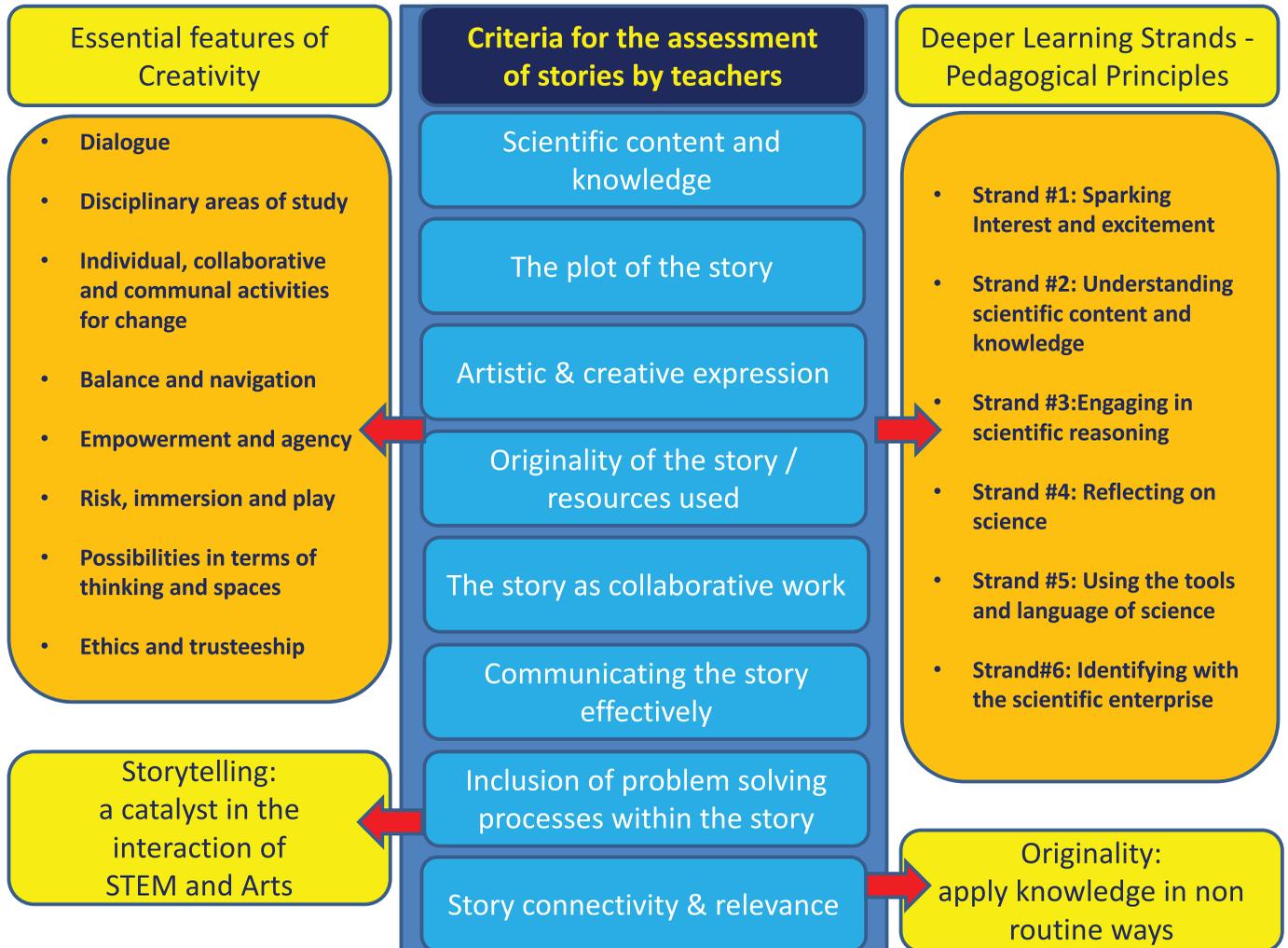
The proposed criteria are the following:

- **Scientific content and knowledge.** How deep the story goes into presenting a scientific theory that is to be confirmed; facts about the mission that reflect upon current scientific knowledge; type of scientific data to be collected or analyzed and conclusions to be used within the story. To what extent scientific vocabulary is used. How much is the story relative to activities performed in class and if it makes use of the knowledge that was acquired through those activities. Deeper learning is demonstrated in the way students apply facts, processes, and theories to real world situation they describe in their story. Each story includes input or facts from various scientific resources. Moreover, the accuracy of these scientific facts presented in each story will also be evaluated. The teacher will evaluate the type of scientific knowledge, the accuracy of the facts presented along with the amount of scientific facts (in a way that the story illustrates storytelling elements and does not follow the structure of a report).
- **The plot of the story.** To what extent scientific vocabulary is used in the plot (consistency). How does the story flow (level of congruity) and if it makes a functional use of the language. How much each story reflects upon students creative thinking skills. Students are encouraged to come up with free-flow generation of unconnected ideas that can be grouped and themed within their story.



- **Artistic & Creative expression.** The quality of artistic content and/or artistic expressions created by students indicates that students enjoy working collaboratively and presenting their creations/knowledge in a non-routine way. How advanced were tools used and how complex was their implementation in the story (level of creativity). What type of artistic expression was created / designed and how difficult it was to construct.
- **Originality of the story / resources use.** How original in the topic or theme that was selected. If original resources created/developed by students (original) for the purposes of the story. Students have procedural knowledge of a content area (presented in their story) and know how content knowledge is produced and for the purposes of their story they create educational resources (they can be in various forms) to enrich their presentation and tailor their message to their audience through storytelling.
- **The story as collaborative work.** How effectively and in how many ways the members of the team collaborated with each other. How even was the distribution of individual and group tasks as well as the work assigned to each member. Was the story efficiently planned and in what different ways all members participated in creating solutions or meeting the groups goals.
- **Communicating the story effectively.** The way the story is communicated to peers not only orally but also by using other forms of non-verbal communication / body language will be evaluated based on its effectiveness. The presentation of the story as a common project with the participation of all students involved.
- **Inclusion of problem solving processes within the story.** If problems related to Mars are introduced and tackled within each story. Evaluation in this section will be based on the problems the students tackle within their mission to Mars and the presentation of the proposed solutions they intent to apply to overcome them. How difficult or how complex are the problems attempted to be solved within the story. The more challenging the topic selected, the higher is the understanding of key principles related to the problem. The complexity of the science presented also indicates the competence of the students to evaluate, integrate, and critically analyze multiple sources of information. The inclusion in the story of identified data and information needed to solve the aforementioned problems will positively add to the story.
- **Story connectivity and relevance.** The story should be in line with the general “Mission to Mars” theme and always reflect upon the scientific core of the activity that is related to our future mission to Mars and attained knowledge. During development of their story within the given scientific framework students understand learning as a social process and actively learn from one another. Stories are formed in episodes and the flow of the story as it moves from one episode to another should be complete by offering scientific facts and details related to the mission without being formed as a science report (facts) or a list of actions and without losing the connectivity with the main theme.

An illustration of the proposed criteria connected to the STORIES Pedagogical framework (including the essential features of Creativity, Storytelling and Deeper Learning) is depicted in the figure below.



*Assessment criteria of stories connected to creativity, deeper learning and storytelling*

The evaluation grid, including the % weight of each criterion is illustrated in the following page:



## STORIES EVALUATION GRID FOR TEACHERS

Criteria for evaluating the stories	Short description of the evaluation criteria	% Weight (point range)	Story Grade
<b>Scientific content and knowledge</b>	How deep the story goes into presenting a scientific theory that is to be confirmed; facts about the mission that reflect upon current scientific knowledge; type of scientific data to be collected or analyzed and conclusions to be used within the story. To what extent scientific vocabulary is used. How much is the story relative to activities performed in class and if it makes use of the knowledge that was acquired through those activities. How accurate are the presented scientific facts.	<b>20 % (0-20 points)</b>	
<b>The plot of the story</b>	To what extent scientific vocabulary is used in the plot (consistency). How does the story flow (level of congruity) and if it makes a functional use of the language. How much each story reflects upon students creative thinking skills. Students are encouraged to come up with free-flow generation of unconnected ideas that can be grouped and themed within their story.	<b>10 % (0-10 points)</b>	
<b>Artistic &amp; creative expression</b>	The quality of artistic content and/or artistic expressions created by students indicates that students enjoy working collaboratively and presenting their creations/knowledge in a non-routine way. How advanced were tools used and how complex was their implementation in the story (level of creativity). Type of artistic expression created/ designed and level of difficulty.	<b>10 % (0-10 points)</b>	
<b>Originality of the story / resources used</b>	How original in the topic or theme that was selected. If original resources created/developed by students (original) for the purposes of the story. Students have procedural knowledge of a content area (presented in their story) and know how content knowledge is produced and for the purposes of their story they create educational resources (they can be in various forms) to enrich their presentation and tailor their message to their audience through storytelling.	<b>10 % (0-10 points)</b>	

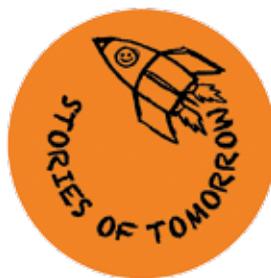
<b>STORIES EVALUATION GRID FOR TEACHERS</b>			
<b>Criteria for evaluating the stories</b>	<b>Short description of the evaluation criteria</b>	<b>% Weight (point range)</b>	<b>Story Grade</b>
<b>The story as collaborative work</b>	How effectively and in how many ways the members of the team collaborated with each other. How even was the distribution of individual and group tasks as well as the work assigned to each member. Was the story efficiently planned and in what different ways all members participated in creating solutions or meeting the groups goals.	<b>10 % (0-10 points)</b>	
<b>Communicating the story effectively</b>	The way the story is communicated to peers not only orally but also by using other forms of non-verbal communication / body language will be evaluated based on its effectiveness. The presentation of the story as a common project with the participation of all students involved.	<b>10 % (0-10 points)</b>	
<b>Inclusion of problem solving processes within the story</b>	If problems related to Mars are introduced and tackled within each story. Evaluation in this section will be based on the problems the students tackle within their mission to Mars and the presentation of the proposed solutions they intent to apply to overcome them. How difficult or how complex are the problems attempted to be solved within the story. The more challenging the topic selected, the higher is the understanding of key principles related to the problem.	<b>20 % (0-20 points)</b>	
<b>Story connectivity and relevance</b>	The story should be in line with the general “Mission to Mars” theme and always reflect upon the scientific core of the activity that is related to our future mission to Mars and attained knowledge. Stories are formed in episodes and the flow of the story as it moves from one episode to another should be complete by offering scientific facts and details related to the mission without being formed as a science report (facts) or a list of actions and without losing the connectivity with the main theme.	<b>10 % (0-10 points)</b>	











<http://www.storiesoftomorrow.eu/>



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