NA-MA POTI

Developing Abilities to Solve Authentic Problems using Digital Technologies

National Education Institute Slovenia

NA-MA POTI

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Developing abilities to solve authentic problems using digital technologies

The content is divided into the following subsections:

- Definition of authentic problems in the STEM-PATHWAYS project
- Guiding questions for assessing authenticity
- Criteria for authenticity, relating to three areas
- Criteria and descriptors for assessing the authenticity of the problem/learning situation
- Developing abilities to solve authentic problems
- Developing abilities to solve authentic problems with Digital Technologies (DT) along the vertical
- Phases of solving authentic problems

List of abbrevations:

DT – Digital Technology
SL – Scientific Literacy
ML – Mathematical Literacy
FL – Financial Literacy
EP – Educational Period
SAP – Solving Authentic Problems
NA-MA POTI – Scientific and Mathematical Literacy: The Development of Critical Thinking and Problem-solving

Definition of authentic problems under the NA-MA POTI [STEM PATHWAYS] project

Authentic problems stem from **life/real** situations and encourage the following during the problem-solving process: **critical thinking, collaboration, creativity, persistence, resourcefulness** and the use of **diverse knowledge and skills**. They enable **different problem-solving methods**. The solutions and their presentations **vary** and **are useful**.

Guiding questions for assessing authenticity

We ask ourselves which of the proposed questions can be answered affirmatively:

- **Choice of initial problem:**
  - Is the problem real/topical?
  - Does it have personal value for the child?
- **Problem-solving pathway:**
  - Is the problem-solving pathway not known/defined in advance for the learners?
  - Will the learners be able to solve the problem in several different ways?
- **Learners' activity:**
  - Does the problem-solving process encourage an independent search for pathways to solutions?
  - Does the problem-solving process encourage learners' creativity, persistence, resourcefulness and the application of diverse knowledge and skills?
- **Solution to the problem:**
  - Are multiple solutions possible?
  - Is the final solution to the problem useful for the problem solver or broader?

The STEM PATHWAYS project also focuses on:

- **Supporting** the SL, ML and FL building blocks:
  - Do the problem-solving activities develop science, mathematical or financial literacy?
- **Using digital technologies**:
  - Is the use of digital technologies a sensible form of support when solving an authentic problem?
  - Does the solving of an authentic problem involve activities that develop digital competences (of children/pupils/secondary school students) along the vertical according to DigComp 2.1?

Criteria for authenticity, relating to three areas:

- Choice of initial problems
- Problem-solving pathway
- Solution to the problem

Criteria and Descriptors for assessing the authenticity of the problem/learning exercise

AREA	CRITERION	DEGREE OF AUTHENTICITY		
		LOW	MEDIUM	HIGH
Choice of initial problem: Is the problem realistic/ current, does the result/ solution represent the fulfillment of the goals and purpose of the chosen learning set and does it have personal value for the student.	Context	Task that isn't contextualized and only appears in a school setting.	Realistic problem, with a somewhat simplified context.	Realistic problem, put into a realistic context, that requires the utilization of a wide repertoire of skills and knowledge as well as a deeper understanding.
	Purpose	There is no other purpose to the task except the school one	Imagined (Simulated) problem with a simulated need	Realistic problem with realistic consequences, i.e., varying degree of success
	Motivation	The motivation is the grade, given by the teacher (external motivation)	Motivation is provided by the design of the task and it's results.	Motivation stems from the attractiveness of the challenge provided by the task and from the satisfaction of the "users" or "public" (inner motivation)
Problem-solving pathway Are there multiple approaches to the solving the problem and does the problem have multiple solutions	Cooperation	No foreseen cooperation between students.	Planned cooperation in the form of work groups.	Cooperation and dialogue between the students, students and teachers as well as others is required.
	Control	No access to sources and interactions, no possibilities of guiding the task, its outcome or purpose.	Some sources and interactions are available and the task can be guided to some extent.	All sources and interactions are readily available and the task progress can be controlled in full.
	Disturbance	No disturbances, obstacles or conflicts built into the task, the task provides only a "lab" setting	Some small disturbances and obstacles are included into the task.	Disturbances and obstacles (technical, contextual, and interpersonal), which are common for these situations.
	Feedback	No feedback during problem solving.	Occasional, non-systematic "school" feedback, during the problem solving part of the task.	On-the-fly feedback from the teacher and classmates according to descriptive criteria arranged beforehand. Allows the students to advance, make mistakes and learn from them, to be critical of their work and to improve upon it. Final feedback comes from »client« satisfaction, possibly through descriptive criteria arranged beforehand.
Solving the problem Is the final solution useful only for the solver or does it have broader applications	Feedback	Number of points, percentage or numerical grade.	Short descriptive feedback from the teacher.	Final feedback from the teacher and the classmates in accordance with criteria arranged beforehand. The final feedback comes from client satisfaction.
	User or Audience	User or audience not foreseen	User or audience foreseen	Real user or audience

Developing abilities to solve authentic problems

The ability to solve authentic problems using digital technologies is the ability to **recognize and understand problems; to independently research, use and synthesize diverse knowledge and digital technologies** to solve problem situations in which the **problem-solving method is not known/defined in advance;** to **critically evaluate the problem-solving procedures and results.**

By systematically and procedurally developing the abilities to solve authentic problems, we are developing knowledge that learners perceive as sensible and that is important for their future lives. Knowledge that will help them to build a "big picture" of the world, or knowledge that will provide them with an in-depth understanding of the phenomena and relationships in the world. In authentic learning situations, learners face concrete challenges, including all the available tools and barriers. On their own – with reasonable support from the teacher – the learners discover and construct knowledge, and look for pathways to solving the problem. Under the STEM PATHWAYS project, we used descriptors for each period of the educational process to define the levels of attaining the ability to solve authentic problems, which the children/pupils/secondary school students should reach at the end of each educational period.

Developing abilities to solve authentic problems using digital technologies (DT) along the vertical

	KINDERGARTEN	PRIMARY SCHOOL			SECONDARY SCHOOL
		1st EDUCATIONAL TRIAD	2nd EDUCATIONAL TRIAD	3rd EDUCATIONAL TRIAD	
Levels of attaining digital competences	**Level of helplessness 1 and 2:** simple tasks with support from others; independently and with support.		**Survival level 3:** Ordinary tasks, simple problems, independently.	**Survival level 4:** Tasks and precisely defined and unusual problems; independently and in accordance with one's needs.	**Level of overcoming barriers 5 and 6:** Diverse demanding tasks and problems; demanding tasks; Providing support to others; adapting to others when performing demanding tasks.
Ability to recognize and understand the problem; to independently research, use and synthesize diverse knowledge and digital technologies to solve the problem and to critically evaluate the problem-solving procedure and results.	Observes and recognizes the problem **in a concrete** situation. **With help from the preschool teacher**, the learner uses **different methods and aids** when looking for a solution. Thinks about the reasonableness of the procedure and the solution; can use DT to support problem solving and the presentation of solutions, **with help from the preschool teacher**.	Observes a problem situation and recognizes the problem. **With help from the teacher,** uses **different methods and tools** when looking for solutions. Thinks about the reasonableness of the procedure and the solutions. Can use DT to support problem solving or the presentation of solutions, with help from the teacher.	Observes a problem situation, recognizes and understands the problem. When solving the problem, the learner uses different methods and aids (**including the use of DT**), and critically evaluates the procedure and the results. Presents the solutions and substantiates them.	Observes a problem situation, recognizes and understands the problem. Extracts the essence of the problem. **Independently, also by using DT**, looks up the required information and plans the problem-solving procedure. Solves the problem using effective strategies. Critically evaluates the procedure and the results; presents the solutions, providing arguments; suggests improvements and changes.	Observes a complex (potentially hypothetical) problem situation. Extracts the essence of the problem. Independently, by using DT, looks up the required information and plans the problem-solving procedure. Chooses and substantiates an appropriate strategy; solves the problem; critically evaluates the procedure and the results. Presents the solutions, providing arguments, and suggests improvements and changes.

Phases of solving authentic problems

The solving of authentic problems envisages that learners go through different phases. The recommended phases are presented below. In practice it is not always possible or sensible to include all the mentioned problem-solving phases in a single activity. What matters is that we follow the order and, above all, that we make sure the implemented phases are well thought out and serve their purpose.

PHASE	ACTIVITIES	DIGITAL TECHNOLOGIES	REFLECTION
0. PRELIMINARY PREPARATION 	The teacher prepares a virtual learning environment with activities for each phase of solving an authentic problem, providing instructions for learners (collaboration, reflection, defining success criteria, etc.).	– Interactive online environments for collaboration and for monitoring the work through reflection (Moodle, MS Teams, Google Sites, SEESAW, etc.). – Applications for forming groups: TeamUp.	 The learners' and teacher's reflection takes place throughout the SAP phases. The teacher and the learners record, write, post and share audiovisual reflections and feedback on their progress in solving the authentic problem, on the challenges, and on their next steps.
1. INSIGHT INTO THE PROBLEM SITUATION (CONCEPTUAL DESIGN) 	Learners discuss the problem; study the practices in their immediate surroundings and the existing material; extract the essence of the problem; brainstorm to solve the problem; take part in defining the success criteria.	– Mind map tools, notice boards, blogs (Padlett, Lino, Bubbl.us, CmapTools, Popplet, Mindmeister, etc.). – Use a smartphone to take photographs, record, scan.	
2. PLANNING 	Learners discuss and exchange opinions about different problem-solving possibilities; discuss and exchange research ideas; contemplate the feasibility (accessibility of the required records, materials, requisites, chemicals; collaboration with external experts; time) and prepare an action plan.	– Tools for editing shared documents (Google Drive, etc.).	

PHASE	ACTIVITIES	DIGITAL TECHNOLOGIES	REFLECTION
3. IMPLEMENTATION 	Learners conduct research: through experiments, using survey questionnaires, collaborating with external experts and institutions. Collaborate throughout, exchange shared documents. Prepare a presentation, product, etc.	– World Wide Web, databases, collaboration tools, social networks (virtual library of Slovenia COBISS, YouTube, Facebook, Twitter, etc.). – Computer-supported laboratory (Vernier interfaces and sensors), online surveys (Arnes Planer, Google Forms, Enka). – Video conferences (Teams, Zoom, etc.), social networks (Facebook, Twitter, etc.). Exchange and co-creation tools (Arnes FileSender, Office 365, Google Docs, MS Teams, etc.).	 Tools for writing down and exchanging reflections (TeamUp, ReFlex, Pedpentool), online blogs (Bloger, Wordpress, Mahara e-Portfolio, etc.).
4. INQUIRY 	Learners collect feedback by asking experts, potential future users, classmates from other groups, and the teacher.	– Video conferences (Zoom, MS Teams, Vox Arnes, etc.), social networks (Facebook, Twitter, etc.). Exchange and co-creation tools (Arnes FileSender, Office, etc.).	
5. IMPROVEMENT 	Supplement and upgrade the product/solution to the problem based on the feedback.		
6. PRESENTATION 	Learners present the solutions, providing arguments; critically evaluate the results and suggest improvements to the problem-solving procedure.	– Presentation tools (Prezi, Powerpoint, Slideshare, Google SketchUp, YouTube, etc.). Knowledge assessment tools (Moodle Quiz, online questionnaires – Google Forms, Arnes Planer, AKF Kviz, Socrative, Kliker, Nearpod, etc.).	

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