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Using HyperDocs to develop scientific competence in elementary and high schools

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Abstract: The purpose of this study is to show how student competencies can be developed purposefully with the help of HyperDocs in both elementary and high schools. It is a specialized lesson designed to provide students with a blended learning experience. During the processing of the curriculum, students communicate, collaborate, think critically, create (4C) in both real and virtual space. The new method helps to constantly maintain the interest and curiosity of students. Through exploratory learning, they receive answers to their questions, expand their knowledge, apply new knowledge. The methodology is based on the own-made HyperDocs illustrations and text, which are related to the Discovery of Mars.

Keywords: key competences, lifelong learning, HyperDocs, methodology, learning outcomes;

1. Introduction

Every day, people of today's modern age are confronted with the development of information technology, software, and applications measurable at the speed of light. It is in this environment that present and future students socialize, and not only students but also the teachers teaching them have to adapt to this accelerated, information-saturated digital and virtual world. According to Szűts (2020), digital pedagogy is a unit of classroom or distance learning methodologies embedded in the information society, in which the teaching and learning process is based on infocommunication tools, screens, databases, and digital content (Szűts, 2020).

Digital pedagogy makes it possible to extend the role of the teacher and classroom and students' cognitive abilities. By augmenting the representation and perception of reality with digital technology, it provides new ways of illustrating educational processes. However, the use of tools alone is not a guarantee of effectiveness. There is a need for solutions that form an integral whole with the methodological practices of traditional education (Pajtókné, 2007.; Farkas, 2015.; Fegyverneki and Aknai, 2017.; Fegyverneki, 2018.; Szűts, 2020).

According to Szalay (2002), algorithmic thinking is characteristic of both real humanities subjects, which facilitate the acquisition and interpretation of information from data, and skills - which facilitate the informative, enjoyable presentation of our thoughts to others, the preparation of appropriate visual and sound effects - are interconnected and appear in a complex way during the application of digital pedagogy in all subjects (Szalay 2002.; Adey and Csapó, 2012.; Farsang, 2020.; Racsko and Révész, 2021).

In line with the challenges of the modern age, it is essential that students possess skills, abilities, attitudes, and key competencies that strengthen literacy, numeracy, and digital competences. At the same time, creativity, participation in teamwork and the ability to innovate are also key to building a career (Council of the European Union, 2018).

Key competencies are the knowledge, skills and attitudes that enable EU citizens to adapt effectively to the rapidly changing modern world and actively influence the direction and content of changes (National Core Curriculum, 2012) (Table 1).

Table 1: Comparison of the key competencies in different regions (the table was modified after Deißinger and Hellwig, 2005).

Australia	UK	USA	EU	Hungary
Key competences	Core skills	Workplace know-how	Key competences	Key competences
Collecting, analysing and organising information	Communication	Information, foundation skills (basic skills)	Literacy competence	Communication competences (mother tongue as well as foreign language)
Communicating ideas and information	Communication, personal skills (improving own learning and performance)	Information, foundation skills (basic skills)	Cultural awareness and expression competence	Creativity, creative creation, self expression and cultural awareness competences
Planning and organising activities	Personal skills (improving own learning and performance)	Resources, foundation skills (personal qualities)	Personal, social and learning to learn competence	Learning competences
Working with others and in teams	Personal skills (working with others)	Interpersonal skills	Citizenship competence	Personal and interpersonal competences
Using mathematical ideas and techniques	Innumeracy (application of number)	Foundation skills (basic skills)	Mathematical competence and competence in science, technology and engineering	Mathematical and thinking competences
Solving problems	Problem solving	Foundation skills (thinking skills)	Entrepreneurship competence	Employee, innovative and entrepreneurial competences
Using technology	Information technology	Technology systems	Digital competence	Digital competences
	Modern foreign language		Multilingual competence	

Key competencies are crucial: personal fulfillment and lifelong learning - cultural, active citizenship and integration into society-social, employability-human capital. Key competencies should be acquired during the period of compulsory education or training. These competences

form the basis of all subsequent learning in lifelong learning. Key competencies are prerequisites for good individual performance, work and later learning throughout life (OFI, 2009).

New Skills Agenda for Europe (Council of the European Union, 2018) makes recommendations on competence in lifelong learning. In the United States, Rotherham and Willingham (2010) see the novelty in how the possession of known abilities, the ability to apply them significantly affects collective and individual success. They draw attention to the importance of the interdependence and interweaving of knowledge and skills (Rotherham and Willingham, 2010).

Strop and Carlson (2010) believe that today's accelerated multimedia, a multimodal world in virtual space requires complex education that uses diverse information sources and text forms. The aim is for students to be able to analyze, synthesize, think critically, and form opinions about different content (Strop and Carlson, 2010).

Software development and wider access to the worldwide internet network and digital tools and platforms provide new types of teaching-learning experiences for teachers and students alike. Students can take virtual tours, create videos, infographics, websites, blogs, vlogs, podcasts, try out simulations, and build virtual worlds using online tools available for free on the web. Using effective teaching methods, access to content and learning experience can be changed and expanded. With its help, students' interest and classroom activity can be increased, and their knowledge can be presented more widely and diversely (Makádi, 2009, 2011a, 2011b, 2015, 2019.; Pajtókné, 2009, 2011a, 2011b.; Teperics et al, 2015.; Lengyelne 2021.; Szűcs, 2022).

2. Hyperdocs as a new teaching-learning method

The term HyperDoc was first used by Lisa Highfill, Kelly Hilton and Sarah Landis, a new method introduced in their book such as *The HyperDoc Handbook*, published in 2016 (Highfill et al., 2016). Hyperdocs is neither a simple online worksheet with hyperlinks, nor is it a Multi-Media Text Sets (MMTS), which is a collection of teacher-selected content related to the curriculum that is available on the Internet (Fig. 1).



Figure 1: Discovery of Mars HyperDocs – Characteristics (MMTS)

The HyperDocs is a specialized lesson designed to provide students with a blended learning experience. During the processing of the curriculum, students communicate, collaborate, think critically, create (4C) in both real and virtual space. The new method helps to constantly maintain the interest and curiosity of students. Through exploratory learning, they receive answers to their questions, expand their knowledge, apply new knowledge (Clark, 2020).

HyperDocs offers a system for powerful lesson design that guides students through the learning process, with students as the focus of document design. Free access to HyperDoc Systems is available for teachers to create and manage these worksheets. HyperDocs is completely web-based. Teachers will explore using HyperDocs as a pedagogical method by completing content assignments in previously created documents during the semester and designing their HyperDocs around content related to their area of certification (Gaffner, 2019).

The advantage of this method is that the available internet content provides a lot of opportunities to process a particular topic and in creating form and content, teachers' creativity can be with wings. Such a HyperDocs worksheet is also excellent for developing competence. The nature of the teacher or the lesson determines what competencies we want to develop. In the course of applying in teacher training, in connection with the compilation of such a worksheet, prospective teachers learn the "dry" curriculum much faster and easier, and

colleagues who are already practicing learn to consciously use and apply it in their daily teaching practice. The worksheet created in the genial.ly interface further expands the possibilities of applying HyperDocs and its visual appearance, with the additional advantage that it can be shared in both Google Classroom and Microsoft Teams (Kárpáti, 2023).

The purpose of using the new method can be of several types:

1. competence development, knowledge expansion and learning support for students,
2. mastering the theory and practice of competence development for university students,
3. In the case of practicing teachers, conscious application of competence development.

3. Discussion

3.1 HyperDocs in general

Mars HyperDocs covers 5 main themes (Fig. 2)

1. Characteristics
2. Survey
3. Morphology
4. Maps
5. Terraforming

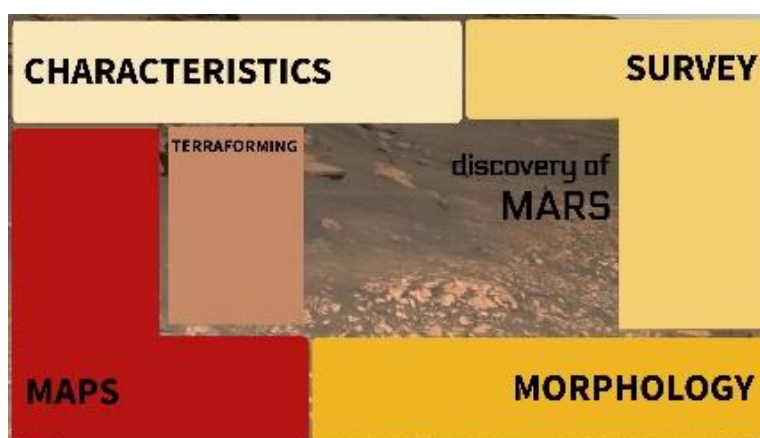


Figure 2: Discovery of Mars HyperDocs

The 5 HyperDocs worksheets process the different units based on the - Explore - Explain – Apply activities (Highfill et al., 2016). Several themes were further enhanced by Engage and Extend actions.

In the Hyperdoc home interface, in addition to the user guide, topics and teacher, student and technical information are indicated. Technical information is a collection of online tools and applications that you can use in your solution (Fig. 3.).



Figure 3: Discovery of Mars Hyperdocs

On the students' information page, you can find downloadable Google Slides worksheets related to all 5 topics, as well as the related thematic page created on the WAKELET interface for uploading finished works (Fig. 4).

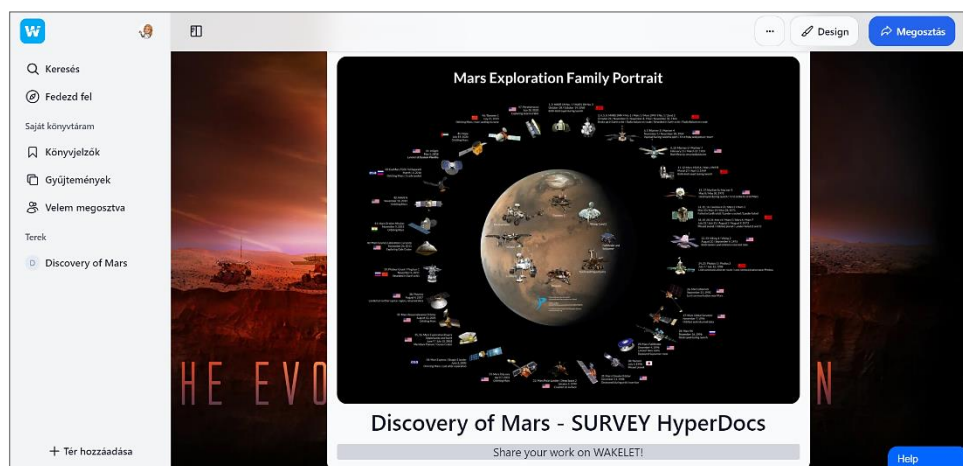


Figure 4: Discovery of Mars Wakelet Choice Board

When compiling the downloadable interactive worksheets, I tried to present knowledge transfer in as diverse forms as possible: read, view, compare, deduce, search for analogies, use simulation, use experiments, use artificial intelligence. Students can present the knowledge acquired during the processing of the curriculum not only with the help of various online

applications in digital form, but also submit creative, handmade creations during their work (Kárpáti, 2023).

3.2 *HyperDocs topic tasks*

1. *topic tasks*: (Appendix A)

- Compare the most important properties and characteristics of the planets Earth and Mars (size, structure, motion, moons) make a graphic organizer about it (lapbook, infographic)!
- Create narration for the Mars transition video, which shows the evolution of the planet.
- Based on the videos, the recognition of Martian atmospheric phenomena, the explanation of their formation, their consequences.
- Listing similar examples on Earth, highlighting and explaining differences.

2. *topic tasks*: (Appendix B)

- Create a timeline of space probes landing on the planet Mars. Indicate: (name, year, nation, success-failure).
- The task of Mars explorer, rover finder (Hargitai, 2023).
- After watching the video, design a landing unit for the future landing Mars probe. Experiment!
- Make a rover out of paper! Print Martian probes in 3D!

3. *topic tasks*: (Appendix C)

- Look on Earth and Mars for examples of the following surface forms: volcano, canyon, polar ice, river valleys, meteorite crater. Determine the geographical position of their central part (Bérczi et al, 2015, 2016).
- The Mars Explorer book is tasked with: Pair map and photo details with the naming of surface shapes (Hargitai, 2023).

4. *topic tasks*: (Appendix D)

- On the website provided, place a map of the United States and your state in the Valles Marineris. Compare their areas! Take screenshots!
- On the website specified in the previous task, use the application to measure the total length of the Valles Marineris. How long would it take to travel the distance, for an

astronaut and a Martian and Lunar vehicle? Convert the given data to Martian day!

- Mars explorer tasked with -Making a planetary map (Hargitai, 2023). Put the pictures in the correct order.
- The task of the explorer on Mars - Topography colorist, Pixelizer (Hargitai, 2023).
- Use papermase technique with your groupmates to create a Mars surface from the Tharsys ridge (Elysium-Amazonis, Chryse Basin, Vallies Marineris).
- Use the models created by the groups to create a Mars field table.
- On Earth, in your country, where do we find an environment similar to Mars?
- Search for photos, videos and create a Google Earth project from the selected locations. Share it!

5. topic tasks: (Appendix E)

- Based on videos, collect what difficulties the first settlers on the planet Mars will face!
- What technical novelties can help terraforming?
- Make a comic book about Martian life!
- How will humanity affect our lives if humanity becomes a 2-planet species?

3.1. *Create a space base model! Mark the components.HyperDocs and its relationship to the competations*

Mars HyperDocs developed a competation, which is based on the competations of Makádi (2019), as follows (Fig. 1):

Communication Competation:

- Effective linguistic communication

Based on the videos, the recognition of Martian atmospheric phenomena, the explanation of their formation, their consequences. List similar examples on Earth, highlight and explain differences (Topic 1: Apply & Share 3).

- Use of information skills (Fig. 5).

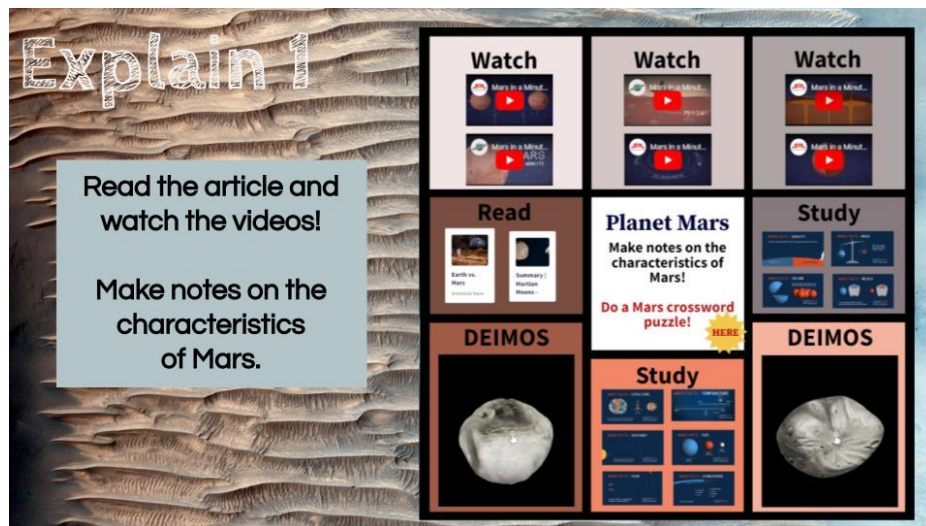


Figure 5: 1. topic, Explain 1.

- Digital communication

Create a timeline of space probes landing on the planet Mars. Indicate: (name, year, nation, success-failure) (2. topic, Apply & Share 1).

- The mass media

Create narration for the Mars transition video, which shows the evolution of the planet (1. topic, Apply & Share 2).

Intellectual Competation:

- Skills of combination

Link them! (Hargitai, 2023) (Fig. 6)

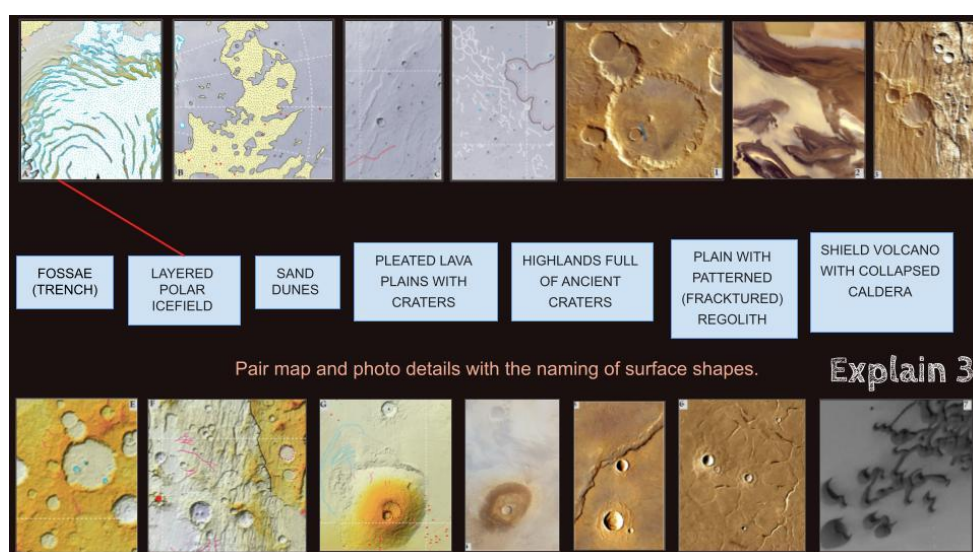


Figure 6: 3. topic, Explain 3.

A Bear on Mars? - Development of critical thinking (Fig. 7).

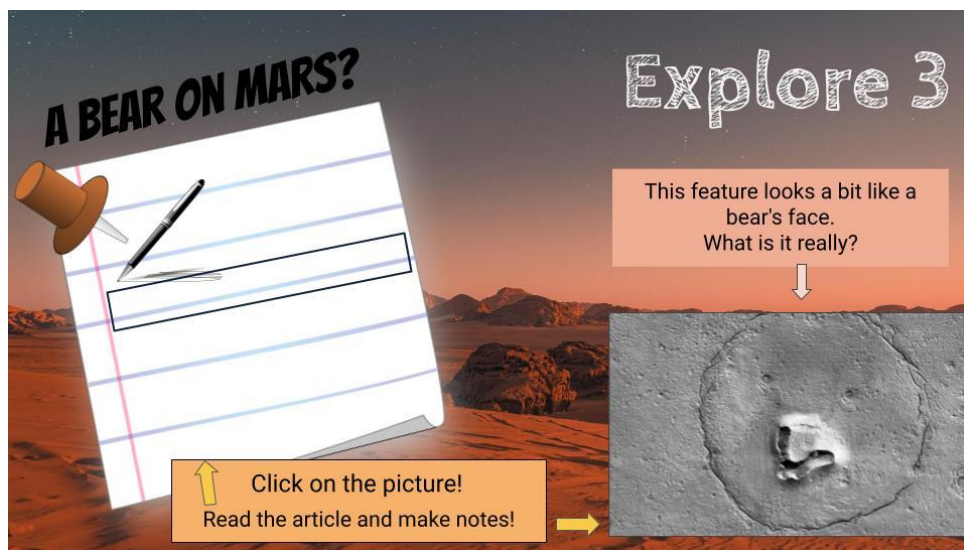


Figure 7: 3. topic, Explore 3

– Effective learning

Based on video, collect what difficulties the first settlers on the planet Mars will face!

Write it down on the notebook! (5. topic, Explore 2.)

Scientific Competations:

– Skills of how to solve problems

Experiment! Watch the video! Design a landing unit for the future landing Mars probe.

Experiment! (2. topic, Apply & Share 3)

Ask NASA Mars! Every question you ask helps it learn. If it doesn't know the answer yet, Mars scientists and engineers will teach it more answers for you (Fig. 8).

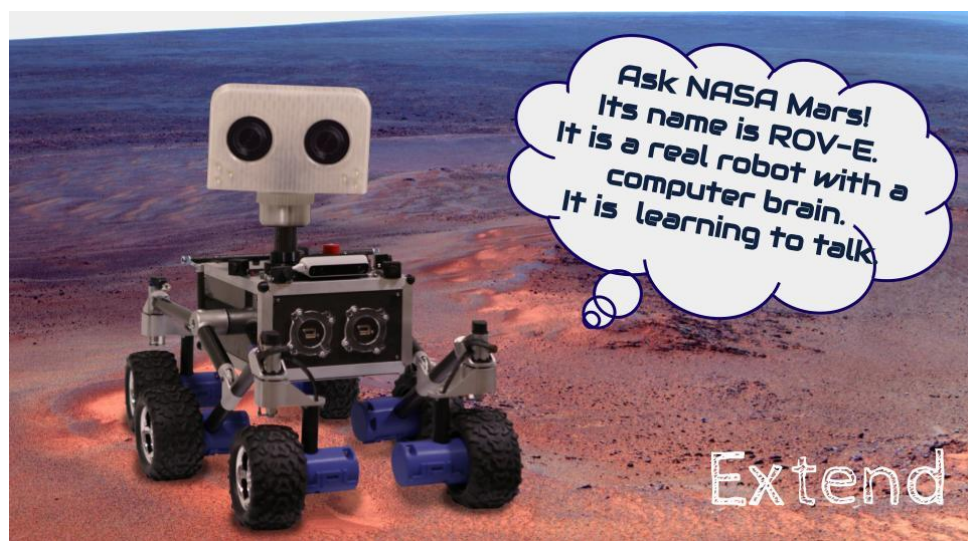


Figure 8: 1. topic, Extend

- Skills of the research

Find an example! On Earth, in your country, where do we find an environment similar to Mars? Search for photos, videos and create a Google Earth project from the selected locations (4. topic, Apply & Share 4).

- Mathematics

What is your weight on another planet? Record your weight in pounds. To calculate your "new weight," multiply your weight by each of the gravitational factors for each planet. Fill in the table! (1. topic, Explain 2)

Measure it! On the website specified in the previous task, use the application to measure the total length of the Valles Marineris. How long would it take to travel the distance, for an astronaut and a Martian and Lunar vehicle? Convert the given data to Martian day! (4. topic, Apple & Share 1)

- Technology and Natural Sciences

Terraforming! Technological developments on Mars (Fig. 9).



Figure 9: 5. topic, Explain

Social Competations:

- Responsibility and Participation of a Society
- Labor, Innovation as well as Business
- Intercultural
- Social

Terraforming! Create a space base model with paper mache technics! Mark the components (5. topic, Apply & Share 4).

- Make a travel brochure! (Fig. 10)

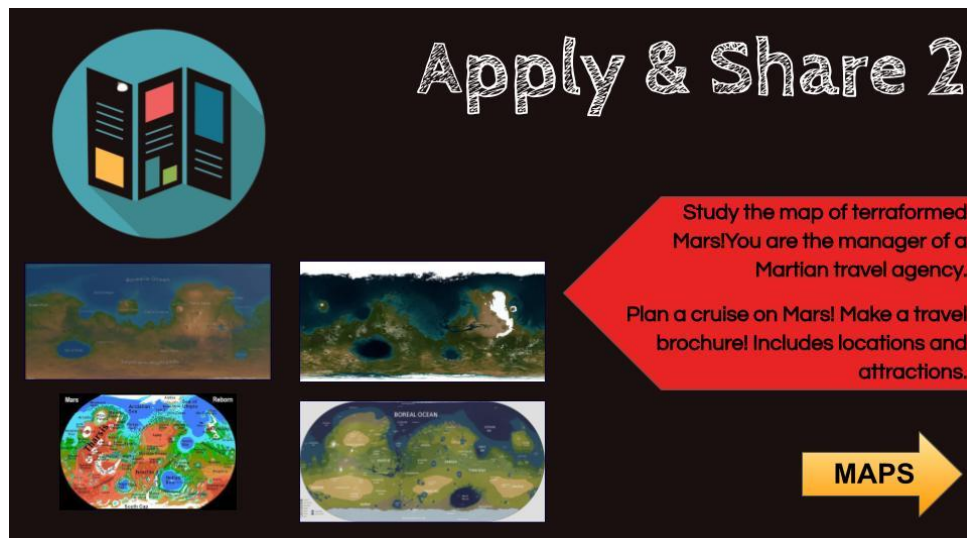


Figure 10: 3. topic, Apply & Share 2.

Watch the video! Form groups and describe the landscape of Mars!

I. Tharsis II. Hellas III. Polar Regions

Characterize the surface of Mars based on the given aspects. The groups should make a poster together (Fig. 11).



Figure 11: 3. topic Explain 1.

Personal Competations:

- Individual

Find your favorite Mars image! Why did you choose this? (3. topic, Explore 3)

Click on the image, open the application and answer the questions! I assigned questions to the video uploaded to the Edpuzzle app. They can be set to proceed only if they have answered the question correctly.

- Identity

How will humanity affect our lives if humanity becomes a 2-planet species? Write it!

(5. topic, Apply & Share 2)

- Creation and Self-Expression

Make a comic book about Martian life! (5. topic, Apply & Share 1)

4. Conclusions

Consequently, the study above has demonstrated the HyperDocs would play a key role in the teaching methods of not only at the primary but also high schools. There is a high ability for the further development of the above-mentioned method with Artificial Intelligence.

5. Summary

With HyperDocs, we can develop students' abilities, skills and competencies in a complex way, while teacher competencies develop during the preparation of worksheets. When solving HyperDocs tasks, students follow individual learning paths at their own pace, their interests are content-driven and motivated. This provides an excellent opportunity for differentiation, catch-up and talent management. During the work they collaborate, discuss and evaluate their ideas.

Through the World Wide Web, teachers use current, up-to-date information and diverse resources, which they can use, update, expand, transform, personalize and group later. Information sources represent multiple points of view, thus developing students' critical thinking and problem-solving skills through research. The completed works are no longer only seen and evaluated by the teacher, but are shared with each other in the virtual space, and presented in the form of an exhibition to school or out-of-school communities in real space. The works of teachers and students are also presented on social media sites, promoting cooperation and networking beyond the borders of schools and national borders. Applied digital pedagogy also rearranges teacher roles, so the teacher becomes a curator, influencer, mediator, tutor, mentor, facilitator and game master in one person (Nagy and Beck-Zaja, 2020.; Nyitrai, 2021).

According to Marshall (2021) by giving students the roadmap for their learning, I have become a passenger on their journey. They are no longer sitting in the back seat, staring blankly out the window and asking, "Are we already there?" With my lesson plan as the schedule and HyperDoc as the vehicle, learning for students became a series of epic road trips. When was the last time someone said that about a textbook (Marshall, 2021)?

In future work, it is intended to examine how digital pedagogy as well as HyperDocs would be affected by Artificial Intelligence (AI).

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Short professional biography

Szilvia Kárpáti is the teacher of Petőfi Sándor Roman Catholic Elementary and High School in Vecsés, majoring in geography and sport. She completed her higher education at Lőránd Eötvös University (BSc) and Károly Eszterházy Catholic University (MSc). Her scientific field is the innovation and methodology for the teaching lectures at primary school as well as higher educational level. Therefore, she gives teaching lectures in Geography at Károly Eszterházy Catholic University. Among her short-term goals is to enter the Doctoral School of Education at Károly Eszterházy Catholic University and start his academic studies.

Appendix A



CHARACTERISTICS

Engage		Your Task
	Watch the VIDEO!	
Explore		Your Task
		- Study the Choice Board! - Name 5 new pieces of information about Mars that you discovered. Make a copy and upload the completed assignment to Google Classroom.
Explain		Your Task
	 	- Read the article and watch the videos! - Make notes on the characteristics of Mars. - Create a Mars crossword puzzle! 1 - What is your weight on another planet? - Record your weight in pounds - To calculate your "new weight," multiply your weight by each of the gravitational factors for each planet. - Fill in the table. 2
Apply & Share		Your Task
	 	- Compare the most important properties and characteristics of the planets Earth and Mars (size, structure, motion, moons...) make a graphic organizer about it (lapbook, infographic)! - Share your work on Wakelet! 1
		- Create narration for the Mars transition video, which shows the evolution of the planet. - Upload the complete video to the WAKELET page! 2
	   	- Based on the videos, the recognition of Martian atmospheric phenomena, the explanation of their formation, their consequences. - List similar examples on Earth, highlight and explain differences. - Share your work on WAKELET! - Connection code: t7krk8rd 3
Extend		Your Task
		- Ask NASA Mars! - Its name is ROV-E. It is a real robot with a computer brain. It is learning to talk. Every question you ask helps it learn. If it doesn't know the answer yet, Mars scientists and engineers will teach it more answers for you.

Appendix B



SURVEY

Engage

Engage		Your Task
		- Explore Mars! - Drive a rover on Mars and collect information about Martian rocks.

Explore

Explore		Your Task
		- Why You Should Become a Martian? - Why thinks Dr. Zubrin we should live on Mars? Make a note! Make a copy and upload the completed assignment to Google Classroom. 1
		- Study the infographics! - Explain the difference between an orbiter and a probe. 2
		- How Do You Get to Mars? - Watch the video! - Make a note! 3

Explain

Explain		Your Task
		Click on the image, open the application and answer the questions! 1
		- Why do you need the heat shield? - How are rovers protected when landing? - Make a table! 2
		- What new information have you gathered about Mars and the rover? - Make a note! 3

Apply & Share

Apply & Share		Your Task
		- Create a timeline of space probes landing on the planet Mars! - Indicate: (name, year, nation, success-failure). 1
		- Find the probes! - Draw the probes in the table. - Solve the puzzle. 2
		- Watch the video! - Design a landing unit for the future landing Mars probe. Experiment! 3
	 WAKELET	- Make a rover out of paper! Print Martian probes in 3D! - Share it on WAKELET. - Connection code: h27zifya 4

Extend

Extend		Your Task
		- NASA Space Voyagers: The Game - Make a Moon or Mars Rover Game - Experience Curiosity - Explore with Perseverance - Mars Rover – Online 3D Simulator by NASA

Appendix C



MORPHOLOGY

Engage	Your Task
	Watch the VIDEO! Best viewed with RED and CYAN 3D glasses.
Explore	Your Task
	 - Click on the image, open the application and answer the questions! 1  - What landforms are found on Mars? - Make a note! 2   - A Bear on Mars? This feature looks a bit like a bear's face. - What is it really? Read the article and make notes! - Find your favorite Mars image! Why did you choose this? 3
Explain	Your Task
	  1 - Read it! Complete the text. - Watch the video. - Form groups and describe the landscape of Mars. I. Tharsis II. Hellas III. Polar Regions - Characterize the surface of Mars based on the given aspects. - The groups should make a poster together.
	- Look on Earth and Mars for examples of the following surface forms: volcano, canyon, polar ice, river valleys, meteorite crater. - Determine the geo- graphical position of their central part. 2
	Pair map and photo details with the naming of surface shapes. 3
Apply & Share	Your Task
	 - Create an info poster for the height of all mons (mountain) on Mars. - This could be as simple as a bar chart or a map of Mars with just the mons location and height on it. - The choice is yours! Be as creative as possible. 1
	- Study the map of terraformed Mars! - You are the manager of a Martian travel agency. - Plan a cruise on Mars! - Make a travel brochure! Includes locations and attractions. 2
WAKELET	Share your work on Wakelet! 3

Appendix D

MAPS

Explore	Your Task
	- Look deeply at the picture for a good long time. Observe shapes, colors, textures, the position of objects. - Complete the tasks in the downloadable Google Slides! Make a copy and upload the completed assignment to Google Classroom. 1
	Watch the presentation and fill in the table! 2
Explain	Your Task
	- Read the article! - Practice and PLAY. - Make a timeline of the Maps of Mars. 1
	- Read the article! - How are planetary maps made? - Make a lapbook. 2
	- Map Channels and Craters on Mars. - Print the maps and complete the tasks! 3
Apply & Share	Your Task
	- On the website provided, place a map of the United States and your state in the Valles Marineris. Compare their areas! Take screenshots! - On the website specified in the previous task, use the application to measure the total length of the Valles Marineris. How long would it take to travel the distance, for an astronaut and a Martian and Lunar vehicle? Convert the given data to Martian day. 1
	Topography colorist, Pixelizer. 2
	- Use paper mache technique with your groupmates to create a Mars surface from the Tharsys ridge (Elysium-Amazons, Chryse Basin, Vallies Marineris). - Use the models created by the groups to create a Mars field table. 3
	- On Earth, in your country, where do we find an environment similar to Mars? - Search for photos, videos and create a Google Earth project from the selected locations. - Share it on WAKELET! - Connection code: 9ufaf4qp - Get inspired. 4
Extend	Your Task
	- Watch the video! - Discover it! - You can made them yourself using a tennis ball by printing Viking Globe or MOLA Globe.

Appendix E



TERRAFORMING

Engage	Your Task
	Watch the VIDEO!
Explore	Your Task
  	- Why is it important for people to go out and explore space? - If offered the opportunity, would you travel to Mars? Why or why not? Make a copy and upload the completed assignment to Google Classroom. 1
	- Based on video, collect what difficulties the first settlers on the planet Mars will face! - What technical novelties can help terraforming? 2
     	- Watch the Youtube videos and articles in any order and answer the questions! - What technical novelties can help terraforming? Make a note! 3
Explain	Your Task
	   - Click on the image, open the application and answer the questions! - What technical novelties can help terraforming? Watch the presentation and make a table! Do you have another idea? - Watch the video and solve the Mars Quiz.
Apply & Share	Your Task
	   WAKELET - Make a comic book about Martian life! - Watch the video! Do you think it's realistic? - How will humanity affect our lives if humanity becomes a 2-planet species? Write it. - Create a space base model with paper mache technics! Mark the components. - Share your work on Wakelet. - Connection code: qv00fo0k
Extend	Your Task
   	- Deepen your knowledge, read! - Test your knowledge! - Play the game! - Is it the FUTURE? Watch the videos! - What do you think? 