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Cognitive Development in A Creative Environment – Online Escape Rooms for Physics Classes

Réka Bencsik, Dr. Dorottya Schnider
Eötvös Loránd University

ABSTRACT:

Our paper examines the pedagogical possibilities and methodological implications of online escape rooms created on the Genially platform for use in physics lessons. I will present the opportunities offered by Genially as an interactive presentation tool, research supporting the effectiveness of escape rooms in the classroom, and provide detailed methodological guidance for designing and implementing online escape rooms tailored to the topics of physics. My goal is to show how elements of gamification can be integrated into physics education to increase student motivation, deepen conceptual understanding, and develop problem-solving skills.

KEYWORDS: physics education, online escape room, Genially, gamification, playful learning, cognitive development, active learning, action-oriented learning, professional methodology, guide

Introduction – motivation and gamification in physics lessons

One of the key challenges of 21st-century education is maintaining student motivation and developing complex problem-solving skills. Physics as a natural science subject often faces the difficulty that students find the subject matter abstract and difficult to understand. Educational research is constantly searching for innovative methods that can overcome these challenges and make learning an enjoyable experience [9] [16] [13].

These innovations are aimed at the specific new needs of the alpha generation born after 2010. These children have been in regular contact with digital devices since an early age, and touchscreens, voice search, and even artificial intelligence are second nature to them [14]. Their communication is also largely based on digital tools, even within the family. From an educational perspective, it is particularly important that they respond better to visual, movement-based and interactive methods, and that they find it more difficult to cope with rapid changes and stimuli due to their ability to adapt quickly to change and stimuli. This is why experience-based, interactive forms of learning – such as escape rooms – are particularly effective for them.

Gamification is an increasingly popular approach in education, which involves the use of game elements and techniques in non-game contexts to increase student engagement and improve learning outcomes. Its aim is to transform learning processes into a playful experience, not to create games for use in the classroom [5]. According to numerous studies, incorporating playful elements into lessons has a positive effect on students' engagement and performance [3].

As a form of gamification, online escape rooms appear particularly promising in science education [15], as they enable students to apply their knowledge in a realistic context similar to the video games they are familiar with in their everyday lives, develop their cooperation and problem-solving skills, while also showing a growing tendency toward positive competition with each other [8].

Previous research has shown that game-based learning, including digital games and escape rooms, has a positive impact on students' learning outcomes, motivation, and attitudes toward science [5] [13]. Online escape rooms are particularly suitable for developing collaborative problem solving and deepening conceptual understanding [1] [2] [6], and can be used effectively in STEM (science, technology, engineering, and mathematics) education [10].

Genially as an interactive presentation platform

Genially is an online platform that allows you to create interactive presentations, infographics, quizzes, games, and many other visually appealing content without any coding knowledge. The platform offers a user-friendly interface where teachers can easily integrate text, images, videos, audio files, and interactive elements.

The interface allows students to become interactive participants in the game by clicking on different elements, moving the mouse over them, or entering certain inputs or codes. Hyperlinks can be easily created between different pages and elements, which are necessary for the logical structure of the escape room. It is possible to embed external applications (e.g., Google forms, YouTube videos, online simulations, LearningApps or Wordwall tasks), which further expands the variety of puzzles and tasks while eliminating the possibility of quickly clicking through the game at random (see also section 3.2).

When designing an escape room, it is worth following the five phases of design thinking: identification (understanding the needs and attitudes of students), ideation (defining aspects of the digital game), prototyping (creating the digital game), testing (having students try out the game), and evaluation (e.g., based on attitude surveys) [16]. This allows us to continuously improve the method based on student needs and feedback.

Instructions for use: designing an online escape room for physics class

General guidance

Below, I provide a step-by-step user guide for designing an online escape room that can be created in Genially.

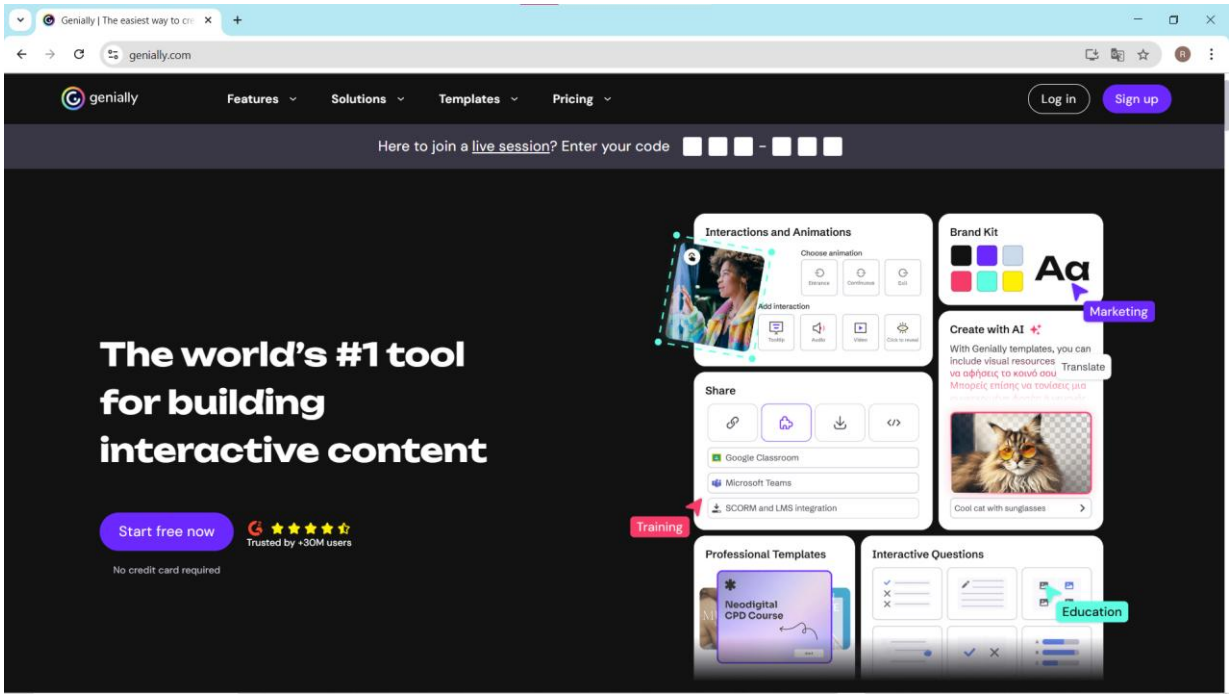

Figure 1 Website address: www.genially.com.

When you open the website (Figure 1) and click on "Start free now," you will see a new interface (Figure 2), where you should select "Education" for educational purposes.

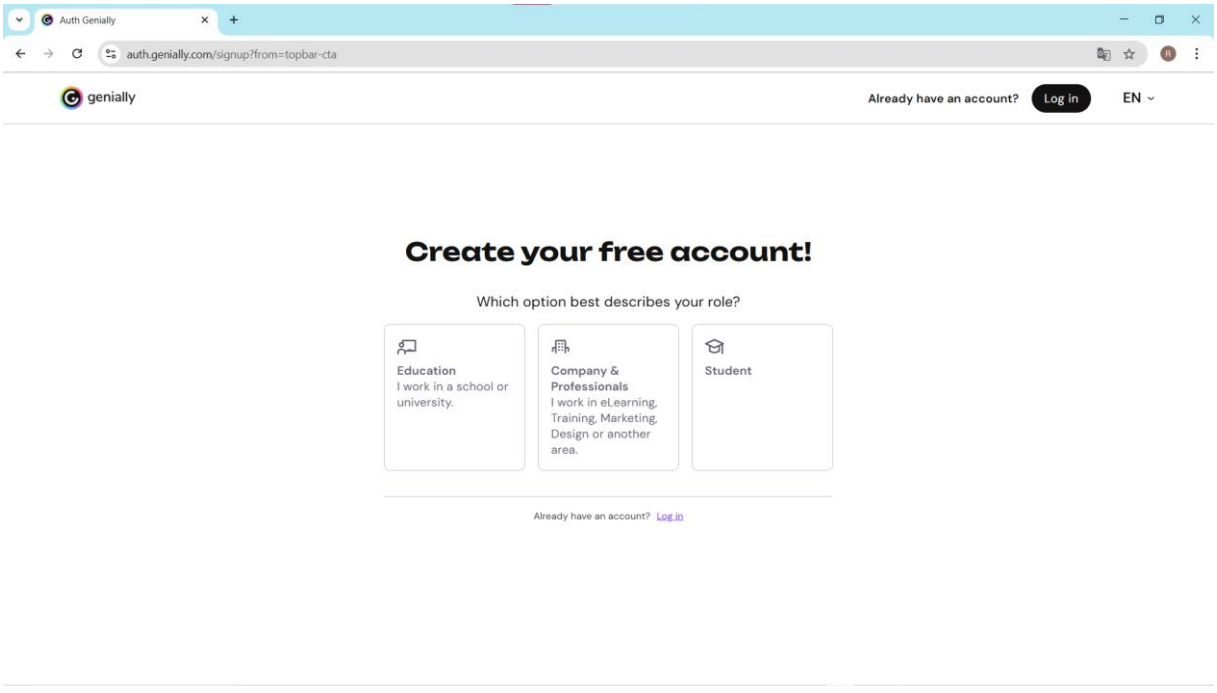

Figure 2 Interface for selecting possible editing targets.

You can then log in using your e-mail address, Google account, Microsoft account, or even your Facebook account. After that, your own editing interface will appear (Figure 3).

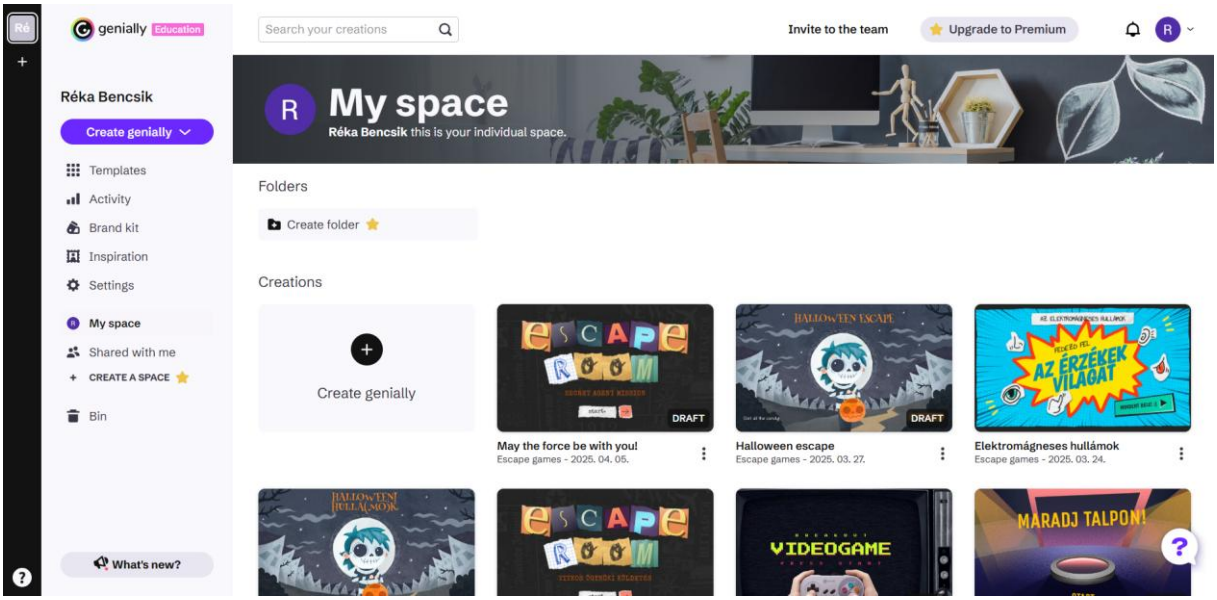

Figure 3 "My space" – the Genially account's own editing interface.

By clicking on "Templates" in the left-hand toolbar, you can see a list of recommended sample tasks, game types, and presentation templates (Figure 4).

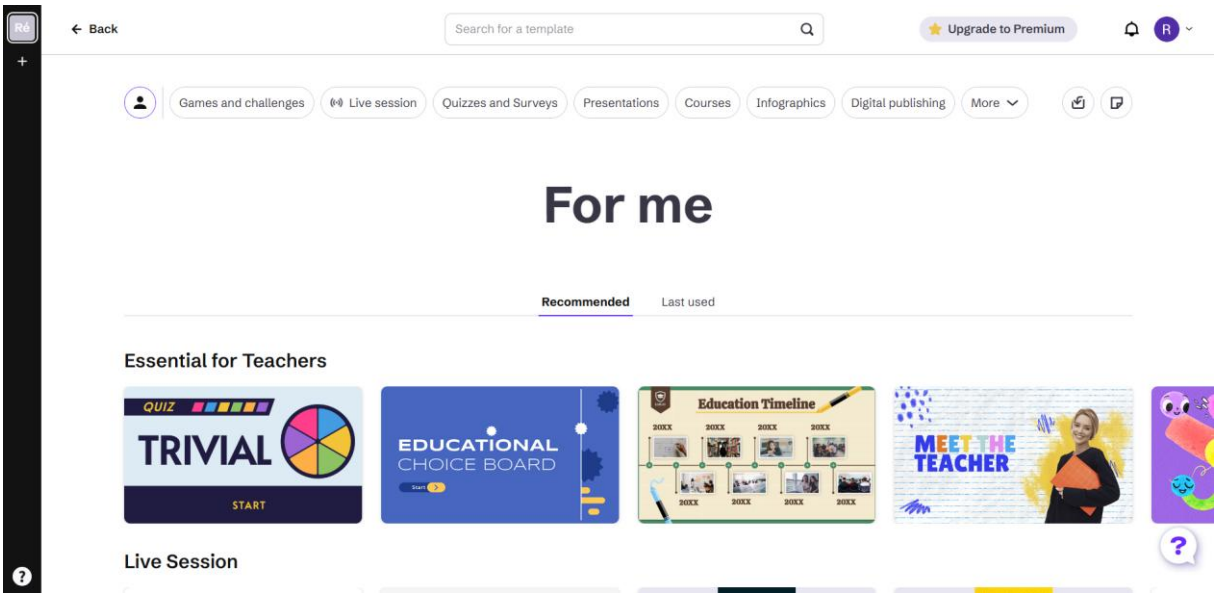

Figure 4 The available templates in a categorized form.

To access the escape rooms, select the "Games and challenges" option from the options available in the top bar, then click on the "Escape games" tab (Figure 5).

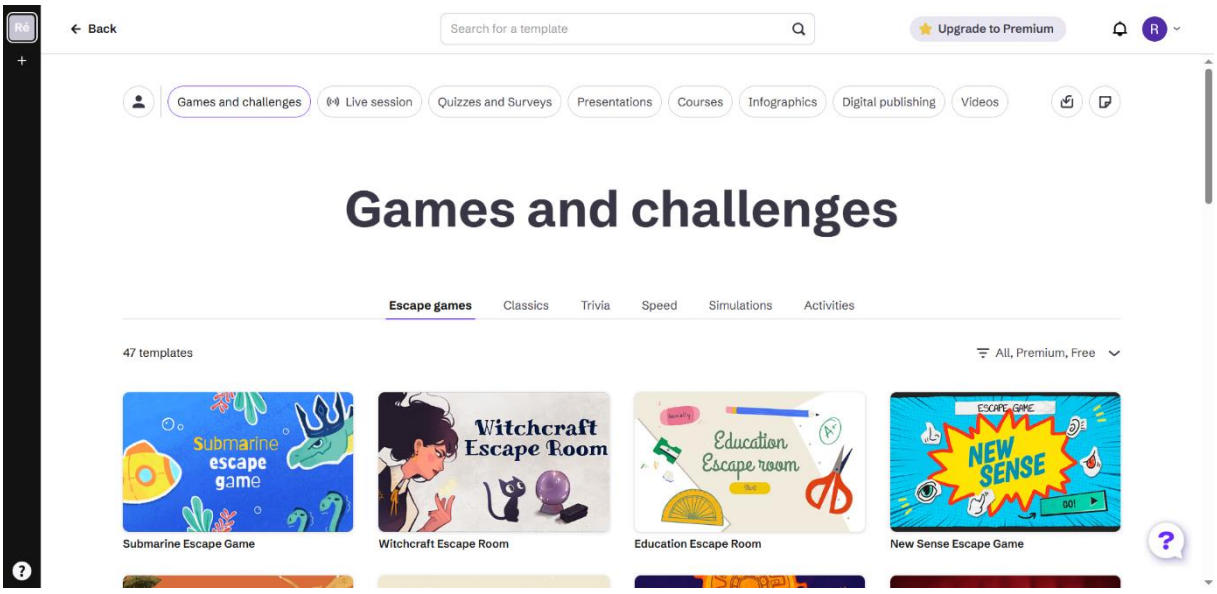

Figure 5 Categorized templates for games and missions.

You can then choose from the templates that appear. Games that are restricted with a premium subscription are marked with a yellow star.

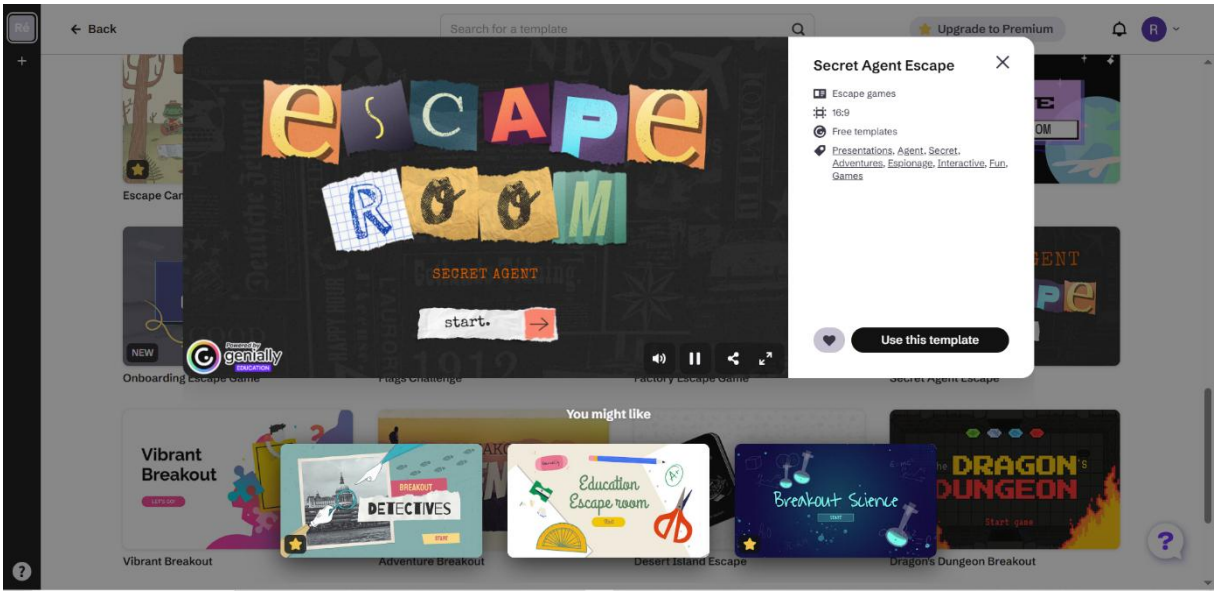

Figure 6 Preview image of a Secret Agent Escape Room.

By clicking on the game we have selected, we can try out the escape room on a preview screen, examining the composition of the factory-integrated task types and interactive elements (Figure 6). These can of course be modified later as desired, but the template provides an excellent basis for compiling the learning unit. Clicking on the “Use this template” icon opens the game editor interface (Figure 7).

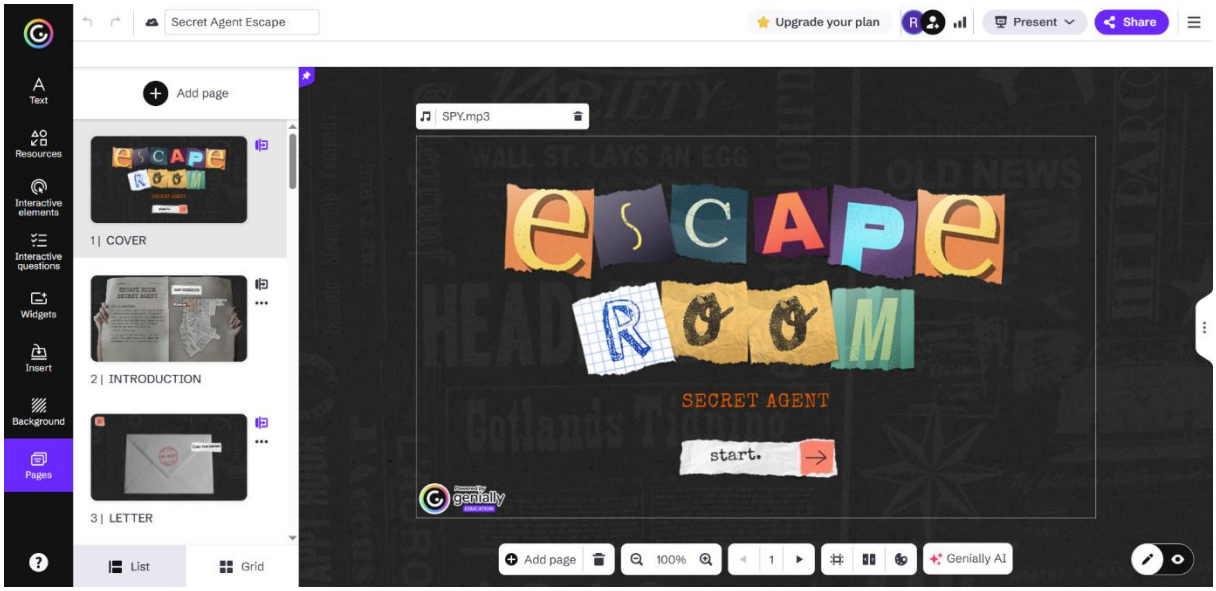

Figure 7 The escape room's editorial interface.

The platform is very similar to a traditional Microsoft PowerPoint interface – you can switch between slides using the bar on the left-hand side. Small icons in the upper right corner of the thumbnails indicate the interactive elements that can be used. For example, in the secret agent template, clicking on the three dots will bring up a number code that can be used to switch between the given pages. This feature helps the teacher to prevent guessing. The student can only move on to the next task if they have solved the previous one correctly and entered the number code they received in return.

If you do not want to use the escape room in its original English version, you have two options: in the free version, you can translate the captions yourself by moving from slide to slide and text box to text box (or using the "Genially AI" feature in the bottom right corner (Figure 11)). With a premium subscription, the platform offers AI-based translation for the entire escape room (which can then be customized as desired).

The next step is to actually start editing. The templates include pre-integrated quiz questions, multiple-choice tasks, and code collection missions. In such cases, the answers already contain the "Correct" or "Incorrect" command. If the answer is correct, the game jumps to the next slide, while incorrect answers are accompanied by a separate slide. Here, players can exit the process or go back to try again. This can of course be modified as desired: an interactive editor icon appears above the answer options – this can be used to select what should happen when the given answer is clicked (jump to the next slide, jump to any slide, exit, continue, etc.).

The left-hand editing bar also has some interesting features: clicking on the "Interactive elements" icon allows you to assign pop-up windows, text bubbles, and audio files to any object in the escape room (Figure 8).

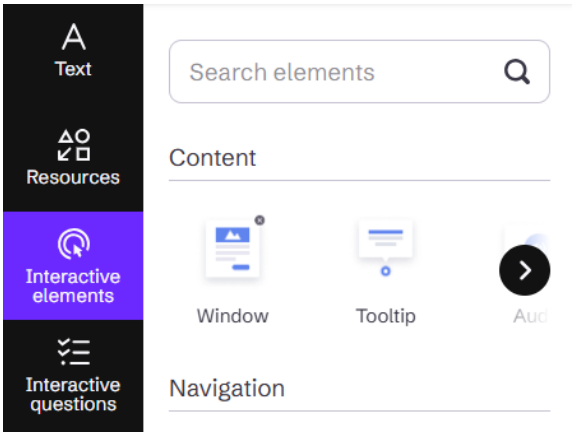

Figure 8 Interactive elements on the editor interface.

Using the next icon labelled "Interactive question," you can select additional multiple-choice questions, true/false questions, image selection questions, or grouping tasks for your game as desired (Figure 9). These can be inserted alongside/instead of the factory-integrated questions.

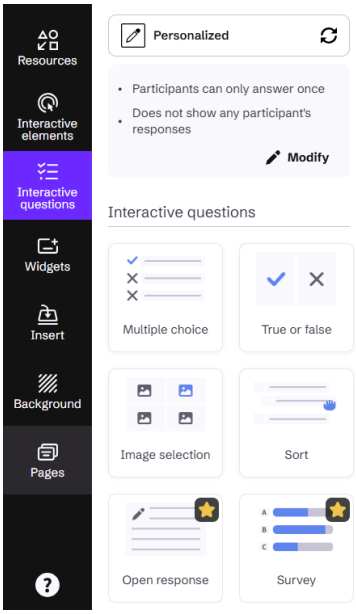

Figure 9 Built-in interactive task types in the editor interface.

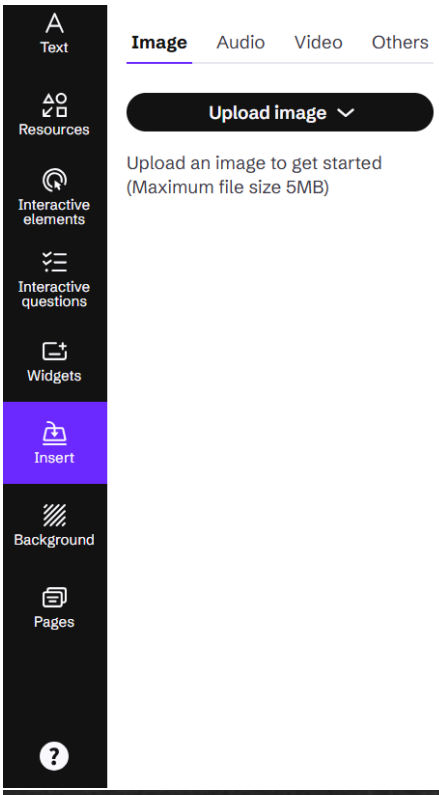

Figure 10 Upload options in the left-hand editor bar.

We can upload different file types to any slide (Figure 10) – these can be useful, for example, when personalizing an image selection task.

The toolbar below the slides is responsible for general settings (Figure 11). Here you can add new windows, delete them, enlarge them, and easily switch between slides. In the fourth white block, in addition to customization, you can also select transparencies, which will appear on the players. We have already mentioned the "Genially AI" feature earlier.

Figure 11 The editing bar that appears below the slides.

Once a particular editing step has been completed, it is easy to check whether the changes work properly in the live game: simply switch from the editing interface to preview mode, which always starts from the current slide (Figure 12).

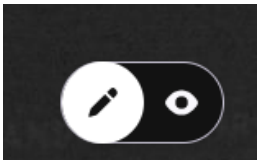

Figure 12 Selection of the editing and preview option.

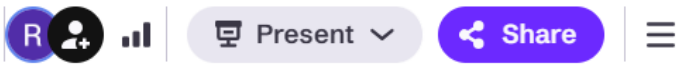

Figure 13 The top editing bar.

The top editing bar offers numerous options for editing the escape room, both during and after completion (Figure 13). Click on the icon on the left to invite co-editors. The "Present" icon allows you to give a presentation without sharing it – even in the form of a live login. By clicking on the "Share" icon, the escape room can be published and shared as a link (Figure 14).

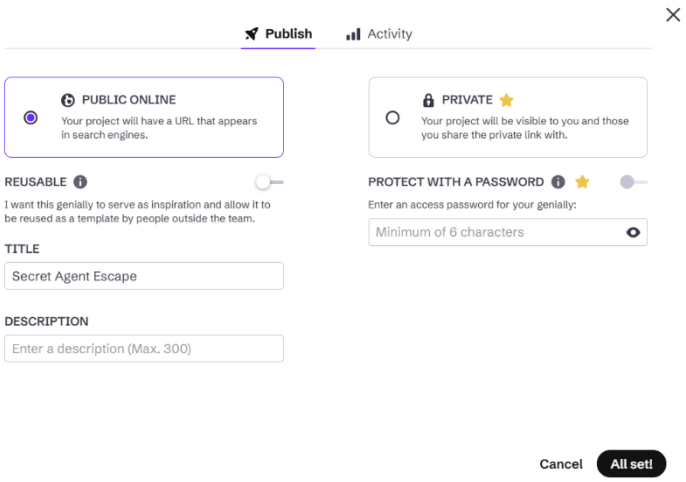

Figure 14 Possibilities for publication. Editing of the escape room by others can be enabled by selecting the "Reusable" option.

How can we avoid guesswork in the answers?

No matter how exciting the game we create for students is, there will always be those who want to win as quickly as possible – meaning they will click through the game quickly, relying on luck. The same phenomenon can be observed when the students do not understand the task and it seems easier to move on without doing any research.

In order to minimize such guesswork, Genially offers solutions that ensure students can only move on (or at least only receive full credit for their work) once they have completed the task without any errors.

One option is to create interactive tasks that only allow players to progress in the game if all the answers are correct. For example, in a multiple-choice task, you can set the correct answers to automatically display a "Correct" or "Continue" button that activates the next step. In most Genially templates, this option is available by default, but there are also templates where you have to set up this feature yourself. To do this, we can again choose from the interactive options whether the game should not allow the player to continue in case of a wrong answer, or whether a window offering a retry should pop up (see section 4.1).

As a next option, we can set that when completing tasks, our students must collect a code without which the next level cannot be reached (see section 4.1). This only works if the code is given by the correct answers.

The difficulty level of the tasks assigned to each room can be gradually increased, so students need more and more knowledge to progress. For some puzzles, you can set a time limit, which increases motivation and reduces the chance of random guessing.

One of the most reliable methods is to integrate tasks with names into the escape room. The "Wordwall" platform provides an excellent opportunity for this. You can choose from a variety of task types (quizzes, matching, grouping, fill-in-the-blank, etc.), which can be inserted as links into any slide in the escape room. When sharing the link, "Wordwall" offers the option to enter a name. This means that at the end of the escape room lesson, we can check whether every student has attempted the integrated task at least once and, if so, what their results were. The "Learning Apps" application is also suitable for similar integration, but here there is no option to set up monitoring.

Task ideas for the online escape room

As mentioned above, it is worth supplementing simple multiple-choice templates with varied, creative task types that make the game more enjoyable and focus on different cognitive levels.

In Germany, operators

There are no sources in the current document.[1] have been used in science subjects since 2013 to classify student performance according to three levels of requirements, targeting basic reproduction, transformation and application, and evaluation and reflection. An educationally and professionally effective online escape room, in addition to being designed for motivational purposes, also focuses on developing these competencies.

The three levels of requirements can be compared to Bloom's 1956 taxonomy, which can also help with planning. The first category corresponds to Bloom's level of knowledge and understanding, the second to application and analysis, and the third to evaluation and synthesis.

The aim of basic reproduction is to recognize and reproduce basic knowledge. It means accurately recalling simple facts, concepts, definitions, and structures. Typical tasks include naming, listing, presenting/illustrating, documenting and recording, describing, and drawing.

This level can be supported in our escape room with the following tasks. The Secret Agent template comes with an interactive ABC where each letter is also assigned a number. For example, you could create a crossword puzzle (e.g., "Physicist, astronomer, and mathematician, he made mathematics the language of physics. – [Solution: Galileo]"), in which the name of the scientist must be spelled out using the letters of the alphabet. The code drawn from the numbers corresponding to the letters can then be requested on the next slide as the code required to continue (Figure 15).

[1] https://www.kmk.org/fileadmin/Dateien/pdf/Bildung/Auslandsschulwesen/Kerncurriculum/Auslandsschulwesen-Operatoren-Naturwissenschaften-02-2013.pdf

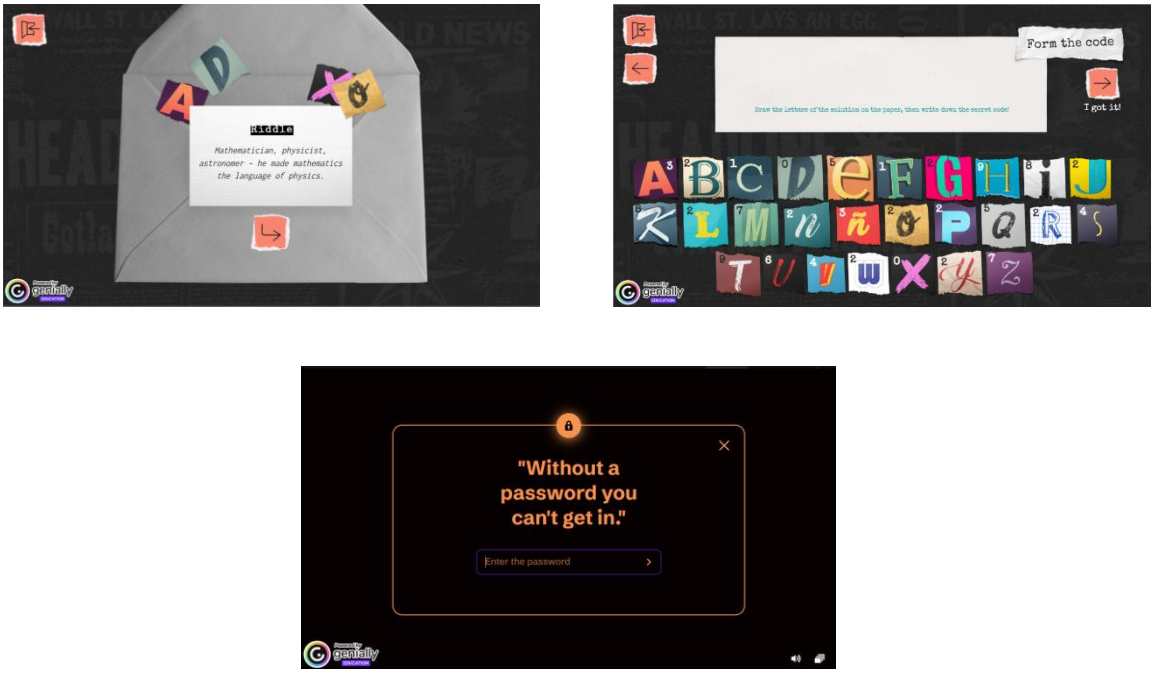

Figure 15 Number code laid out from an interactive ABC at the basic reproduction level.

The name and list operator can be used as links in Wordwall tasks. You can create texts with gaps where students can practice recalling definitions or listing characteristics of the missing words. The correctly solved task can be cleverly incorporated into the factory quiz in our escape room – for example: "Open the link below and solve the quiz! Password required to continue: twice the number of questions minus 10, followed by a word that rhymes with the result! [Solution: 10 (ten) – possible answers: Nero, empty, Ben]" (Figure 16).

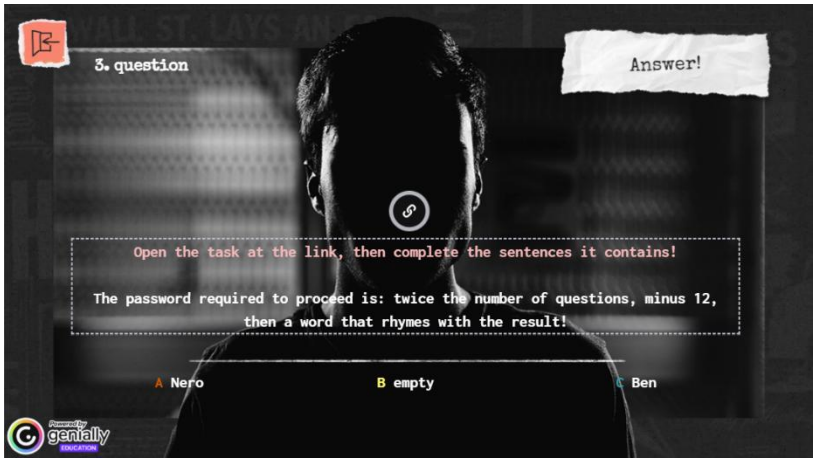

Figure 16 Integration of Wordwall tasks into the multiple-choice basic quiz.

We can even create a Wordwall quiz, where we also test basic knowledge – in this case, we can also use tricky connecting tasks, where our students can choose the correct answer from the four options offered in the escape room – for example: Open the link below and fill in the gaps! Password required to continue: the word formed from the first letters of the words entered." An additional challenge here is that the initial

letters must be placed in the correct order to form a meaningful word related to the topic.

Matching tasks also belong to level 1 (provided that no explanation is requested for the matching). A good example of this is finding the opposite force to a given force. The pairings can also be inserted as Wordwall tasks, but most of the templates already have this type of interactive element. The order of the pairs can be indicated by letters, and the resulting combination can be used as a code for the next level (Figure 17).

Figure 17 A matching task corresponding to the first cognitive level.

In addition to enhancing the simple multiple-choice format, the exercises listed above also eliminate guesswork. If a student does decide to take advantage of this option, Wordwall's excellent feature allows us to check afterwards on the "Leaderboard" interface who did not attempt the integrated tasks (see also section 3.2).

The level of transformation and application is already based on understanding and using connections and organizing information. Its typical tasks include application, analysis, deduction, estimation, calculation, description, definition, explanation, systematization, verification, generalization, comparison, and summarization.

Accordingly, numerous tasks can be associated with the second level. With the Secret Agent template, you can create simple or even more complex calculation tasks where data hidden in text related to the topic must be substituted into the learned relationships. After that, you can vary the way you proceed as you wish. One option is to hide the text of the tasks in images that contain letters. By

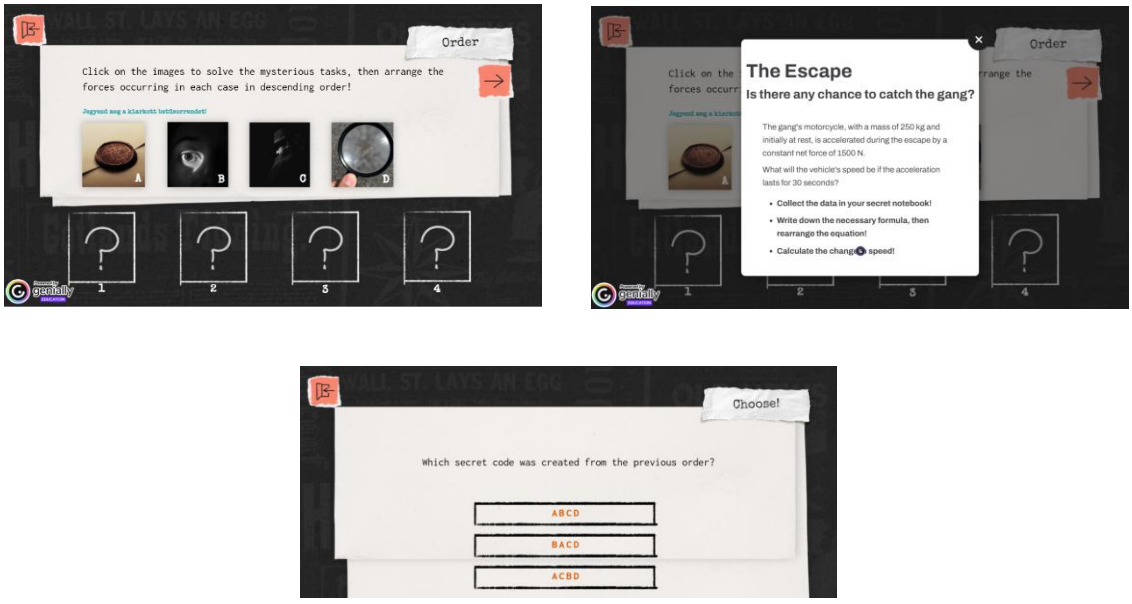

Figure 18 Integration of calculation tasks into the escape room template.

arranging the solutions to the tasks (i.e., the numerical values) in ascending (or descending, etc.) order, we obtain a string of letters, which can be used as a code at the next level (Figure 18).

Of course, calculation tasks can also be inserted into the simple quiz template – in this case, it is worth marking answers with incorrect units of measurement and numerical values that are not correctly substituted into the given context as incorrect answers.

The next type of task is explanation and justification. This is difficult to integrate into closed-ended quiz questions, but we can provide answer options from which children must select the one that best fits the given phenomenon. This can also be illustrated with a diagram (Figure 19).

Figure 19 Diagram analysis with explanations.

Below, I will provide an interesting example of systematization. When introducing the topic of mechanical waves, you can insert a Wordwall task into the escape room, where students have to classify different types of waves (e.g., sound, light, X-rays, water waves, microwaves, etc.) into mechanical, electromagnetic, and gravitational waves based on pictures and names. Once the children have solved the task, the password required to move on is a sentence formed from words beginning with the initial letters of the mechanical wave types. The same game can, of course, be used to explore other topics.

Interesting tasks can also be associated with control as an application level. A possible example is the practice of strength types and friction (Figure 20). We can write stories for the escape rooms – in Figure 20, this involves moving a chest. For the next slide, we can assign a Wordwall task where students must identify the "scientific mistakes" made by the characters in the story. When creating the password required to proceed, we can once again be creative – e.g.: "Which diagram correctly shows the forces acting on the box during movement?" (this also practises analysis) or (as shown in the diagram) "What is the counterforce to the force acting on the box?" or "When is the friction force greater?" Just before the crate moved, while it was sliding or perhaps during rolling?"

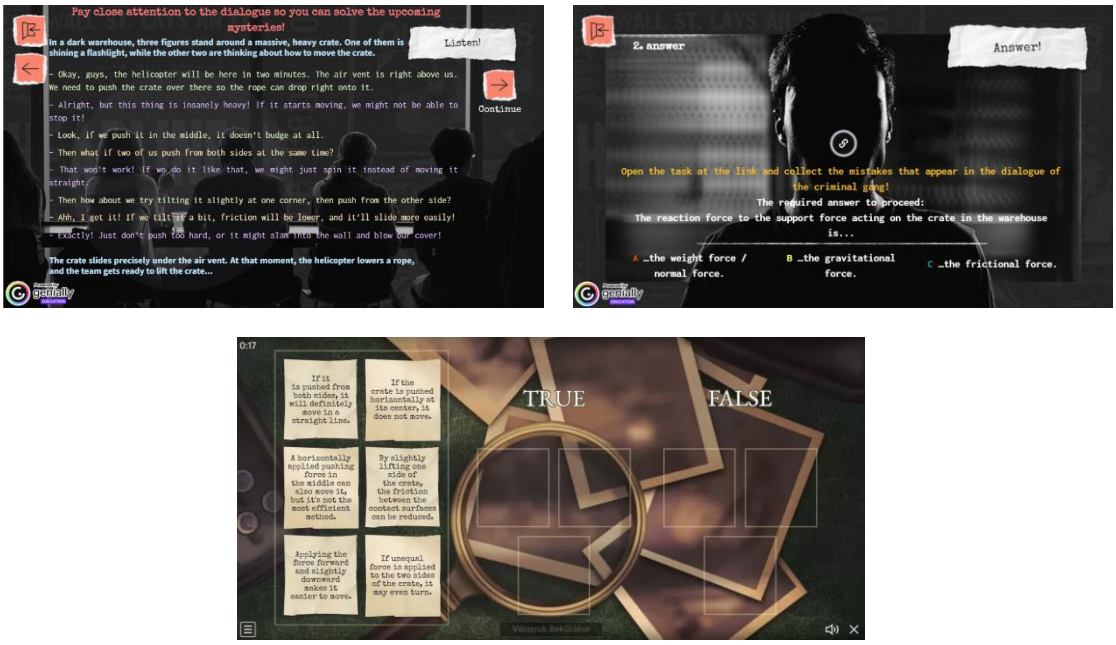

Figure 20 Control as a task associated with the application level.

The highest cognitive level is developed by task types that require independent opinion formation, interpretation, justification, and critical thinking. The aim is for students to expand, combine and evaluate the knowledge they have acquired. The operators typically used here are commenting, evaluating, discussing, justifying, hypothesizing, and interpreting.

Since most of these tasks require open-ended responses, they are more difficult to integrate into quiz-style games.

The explanation accompanied by the diagram analysis shown in Figure 19 can be included among the task ideas listed above.

For tasks requiring interpretation, we can also use PhET or Vascak simulations. Returning to the topic of waves, without any prior knowledge, we can introduce the concepts of transverse and longitudinal waves solely by examining the attached simulation (Figure 21).

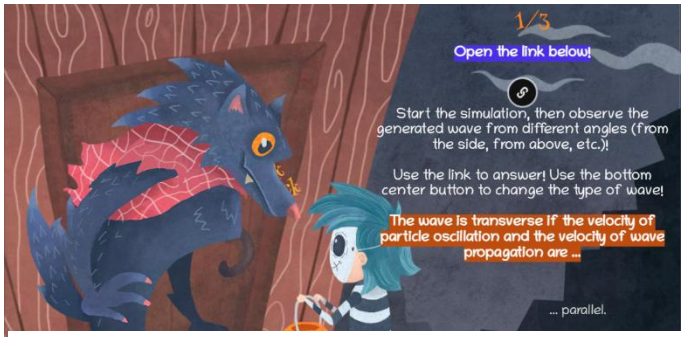

Figure 21 Simulation study of transverse waves. (https://www.vascak.cz/data/android/physicsatschool/template.php?f=kv_vlnostroj&l=hu)

Similarly, we can use videos and video parts. These can even be combined with LearningApps exercises. The video stops at certain points, and then a question appears in LearningApps, which we expect the student to answer based on the video. The code can then be used to provide a correct explanation or interpretation of the phenomenon shown in the video, which can be selected from the quiz options.

Opinion forming and hypothesis building can also be practiced using Genially quiz templates. To do this, we can raise a specific problem and hide the consequences among the possible answers. For example:

1. ***"Radio waves carry sound through the air in the same way as mechanical sound waves."***

A) *The statement is correct, as radio waves and sound waves travel in similar frequency ranges.*

B) *This is partly correct, because sound is produced in mechanical form, but it is converted into electromagnetic waves in the microphone.*

C) *The statement is incorrect: radio waves are electromagnetic waves, while sound waves are mechanical waves; their physical nature is different.* ✓

D) *The statement is correct, as radio waves act as a "carrier" that transmits sound waves through the air.*

2. ***"The greater the amplitude, the faster the wave propagates."***

A) *The statement is correct because an increase in amplitude means more energy, so propagation is faster.*

B) *The statement is incorrect: wave velocity is determined solely by the properties of the medium, not by the amplitude.* ✓

C) *The statement is partially true because it applies to longitudinal waves.*

D) *The statement is only true for electromagnetic waves.*

We can also introduce the "What if..." thought experiment game, in which students have to imagine the physical consequences of a hypothetical situation. For example:

"What would happen if only one force acted on a body?"

A) *The body would move faster and faster in that direction.* ✓

B) *The body would move uniformly in the direction of the force.*

C) *The body would slow down and then stop.*

D) *The body would start spinning.*

The example presented is also intended to dispel the misconception that force is required to maintain motion, rather than to change the state of motion. The length and difficulty level of the answers can of course be adjusted as desired.

As the examples above show, there are many creative ideas that can be incorporated into Genially templates. However, it is important to note that the purpose of classroom games is not only to increase motivation, but also to develop the cognitive abilities of students through action-oriented methods.

Attitude test among secondary school students in grades 7 and 10

Compilation of the attitude test

The assessment and emotional acceptance of physics students significantly influences the success of the learning process and the long-term retention of knowledge. Beyond cognitive performance, student attitudes, i.e. feelings and motivational factors related to the subject, teacher, learning method, and the social role of physics, are playing an increasingly important role.

Attitude tests make it possible to measure the impact of pedagogical innovations not only on the basis of performance indicators, but also on the basis of the feedback of students on their experiences. Such measurements provide teachers with feedback on how students perceive a given method, thereby improving

the quality of learning organization [12].

A common tool for measuring attitudes is the Likert scale, which records students' subjective opinions in a structured, quantifiable form. The six-grade Likert scale does not include a middle, neutral option, so respondents are forced to take a position in one direction or the other, thus providing a more accurate picture of the polarization of student attitudes [4] [11].

Typical grades on the scale may be:

1. I completely disagree.
2. I rather disagree.
3. I slightly disagree.
4. I slightly agree.
5. I rather agree.
6. I completely agree.

I tested the escape rooms, which were enriched with the task types presented, in two classes, then collected the opinions of students using an attitude test. Seventh-grade high school students participated in a game based on the Secret Agent template, which focused on forces and types of forces, while tenth-grade students were introduced to mechanical and electromagnetic waves using this method. The test questions can be found among the results (section 4.2).

Test results

During the research, a 6-point Likert scale attitude questionnaire consisting of 21 items listed in Table 1 was completed by students in grades 7 and 10 ($N_{Grade\ 7} = 23, N_{Grade\ 10} = 24$). The questions can be divided into four thematic subscales: cognitive impact, affective impact, metacognitive impact, and digital learning experience.

The test statements and statistical data characterizing student assessment are presented in Table 1.

Statement	**Student assessment**	
	Grade 7	**Grade 10**
	average (standard deviation)	
Cognitive impact – learning effectiveness and understanding		
1. The tasks helped me organize my knowledge related to the given physical topic.	4.48 (1.08)	4.63 (1.25)
2. During the game, I had to recall and apply physical concepts I had learned earlier.	5.78 (0.42)	4.63 (1.06)

3. While completing the tasks, I also discovered new connections.	4.04 (1.22)	4.54 (1.10)
4. I feel that despite the playful format, the material was retained more deeply than in a traditional lesson.	4.52 (1.44)	4.58 (1.32)
5. At the end of the escape room, I felt more confident about my knowledge of the subject.	3.78 (1.31)	4.38 (1.56)
Affective impact – experience, motivation, attitude		
6. I enjoyed the class because I found the assignments challenging.	5.09 (1.28)	5.67 (0.70)
7. The escape room made physics class more exciting for me.	5.48 (0.73)	5.25 (1.29)
8. I felt myself more active during this class than usual.	4.87 (1.14)	5.00 (1.18)
9. I paid more attention during the class than usual.	4.04 (1.72)	5.04 (0.91)
10. This form of learning increased my interest in the subject.	4.52 (1.08)	4.21 (1.44)
11. The playful environment reduced my anxiety in physics class.	4.65 (1.67)	4.92 (1.47)
Metacognitive effect – independence, problem solving, learning awareness		
12. I consciously directed my thinking throughout the task.	4.00 (1.45)	4.29 (1.33)
13. In the escape room, I was able to work at my own pace and independently.	4.87 (1.42)	5.38 (0.88)
14. The tasks prompted me to try out different approaches.	4.57 (1.24)	4.75 (1.11)
15. During my individual work, I gained a better understanding of how I think about physical problems.	4.22 (1.76)	4.58 (1.28)
16. The escape room had a motivating effect on me during my studies.	4.13 (1.49)	4.21 (1.35)
Digital learning experience		
17. The digital interface of the escape room was easy to use and clear.	4.83 (1.44)	5.13 (1.26)
18. Visual and interactive elements aided understanding.	4.52 (1.56)	5.29 (1.12)
19. The escape room was more like a game than learning.	4.57 (1.38)	4.13 (1.51)

20. I would love to study physics in this format again.	5.57 (0.99)	5.38 (1.49)
21. I would like to learn other subjects in a similar way.	5.57 (0.95)	5.29 (1.37)

Table 1 The attitude test questions ("Statement" column) and the development of student assessment in the grades examined (7th and 10th grades). In the table, significant differences can be observed between the grades in questions 2, 6, 9, and 18 – here, blue indicates the average of significantly different responses from 7th graders, pink indicates the average of significantly different responses from 10th graders, and the standard deviation is shown in parentheses.

The average scores for each question were above 4 for most items in both grades, indicating a generally positive attitude. The highest scores were given by students for items related to playfulness, motivation, and digital experience, while the lowest scores were related to technical challenges or self-reflection. See Figures 22 and 23 for the results.

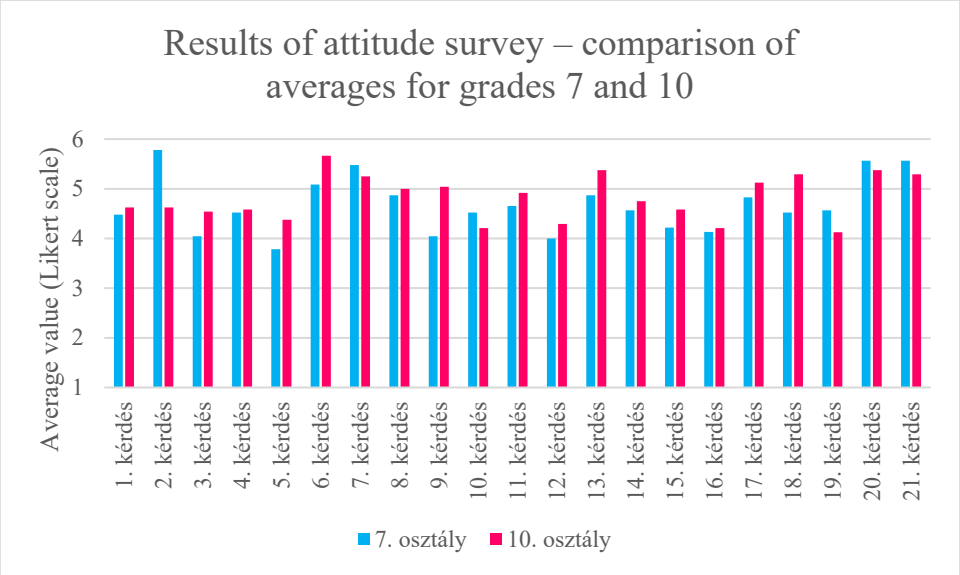

Figure 22 Comparison of the average scores for each question in grades 7 and 10 in a bar chart. In questions 2, 6, 9, and 18, there is a significant difference between the responses of the different grades.

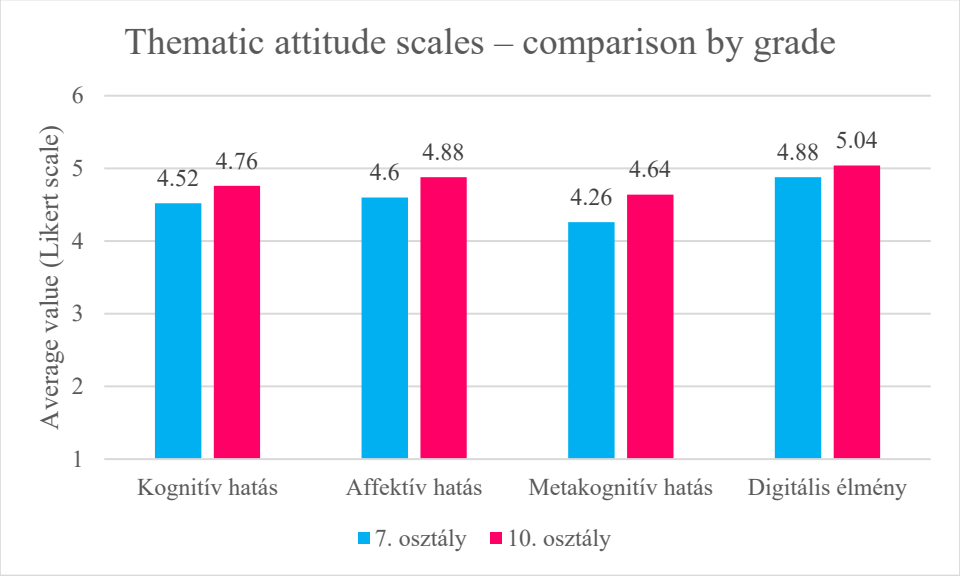

Figure 23 Comparison of averages according to sub-scales for grades 7 and 10 in a bar chart. The values can be read at the top of the columns.

In order to measure any differences in students' attitudes toward the escape room method between age groups, as well as the various effects of the game (Figure 23), I statistically compared the average responses of the grades for each question (Figure 22) and each subscale (Figure 23), as well as the significantly different average values between age groups.

Due to the small sample size, I used a Mann-Whitney U test after a normality test to compare the groups. The shaded cells in Table 1 show the questions where there was a significant difference between student opinions.

Grade 7 students scored significantly higher on statement 2 of the test *("During the game, I had to recall and apply previously learned physical concepts.")*. The reason for this is that while the 10th graders were mainly learning new material with the help of the game, the 7th graders were using the method to summarize what they had already learned. Thus, for seventh graders, the new format of the task series proved to be a useful aid in recalling and applying the knowledge learned in traditional lessons.

In the case of questions 6 *("I enjoyed the lesson because I found the tasks challenging")* and 9 *("I paid more attention during the lesson than usual")*, the responses of 10th graders can be considered significantly higher. Playful learning and teaching methods are traditionally more effective in upper grades, while high school students prefer explicit, clearly stated and well-structured teaching and learning methods. However, this seems to be changing in the case of Generation Z (10th grade). Research shows that while goldfish can concentrate for 9 seconds, human attention spans have dropped to 8 seconds [7]. In this world of "many answers, few questions," education must compete with countless other stimuli. As the results show, escape room-based learning proved particularly useful for keeping the attention of 10th grade Generation Z students. The escape room introduced students to the new topic through a variety of tasks, while rapidly changing images and a video game-like appearance increased the high school students' motivation to learn physics. All this clearly shows (see question 6) that the escape room is not just a game for them, but also a task to be

completed.

As another explanation, or to supplement the previous one, I would like to mention that the 10th grade students participating in the test encountered the escape room method for the first time during their four years of physics studies, so the game as a form of learning was new and unusual for them. In contrast, seventh graders have been working on colourful and varied tasks that encourage active participation in class since their first physics lesson. Computer tasks are common in their physics lessons, so the escape room method was not really new to them. From the outset of their studies, they regard computer games as "normal"; for them, this teaching technique is traditional. However, our 10th grade students have encountered numerous methods and work forms during their physics studies, so they have a basis for comparison, can accurately determine which methods are beneficial and exciting for them, and are better able to appreciate playful tasks.

The 10th grade also gave significantly higher scores to question 18 of the questionnaire *("Visual and interactive elements helped understanding.")*. This statistical result can again be linked to the students' background in physical studies. Over the course of four years, they were taught by four different teachers, so the logical, transparent nature of the digital elements could be an important key to organizing their existing knowledge. Meanwhile, it continues to build on generational characteristics and the prominent role of digital devices. While earlier research (e.g., [7]) showed that high school students need explanations from teachers, there's been a generational shift since then, and educational needs have changed, so understanding can now happen through other channels. However, this requires thorough planning, a well-thought-out structure for the learning process, and careful selection of task types that involve students in the active process of processing the material.

Based on the results of the questionnaire, the digital escape room as a form of learning organization was met with a high degree of acceptance and positive attitudes among students, especially in terms of affective and digital experience dimensions. The high average score and the reliability of the scale confirm that the method may be suitable for achieving complex learning goals, not just as a playful motivational element.

Conclusion

Online escape rooms created on the Genially platform can be an exciting and effective tool for teaching physics. Escape rooms enriched with the best practices presented above prove to be particularly useful when used in the classroom. Such a playful, interactive learning environment contributes significantly to increasing students' intrinsic motivation. For students, completing challenges and experiencing immediate success is motivating in itself, which increases activity and attention during class.

The use of this method also adds variety to traditional classroom activities, preventing monotony and maintaining students' interest in the long term. The varied and creative tasks in escape rooms enable students to process the material in an experiential way, which leads to deeper knowledge acquisition in the long run.

From a pedagogical point of view, it is a significant advantage that teachers are constantly present during the use of escape rooms in the classroom, providing support and guidance as well as personalized assistance. The home environment often lacks immediate feedback, the positive effects of group dynamics, and the framework and support provided by teachers. In contrast, the classroom escape room offers a

controlled learning environment that provides differentiated support for students' individual development and promotes effective learning of the subject matter. It is worth spending an entire lesson on this so that students can learn the rules of the game and complete the tasks step by step.

It is worth making the link to the game available so that students can access it at any time, allowing them to use it for practice or revision at home before tests.

By following the methodological guide, physics teachers can create their own online escape rooms tailored to their curriculum, enriching their lessons and making physics learning more experiential and action-oriented.

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