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András Béres – Ágnes Bálint

ESCAPE ROOMS IN GEOGRAPHY EDUCATION: AN INNOVATIVE APPROACH TO LEARNING AND TEACHING

Abstract

Background: The use of escape rooms in education has gained traction as an innovative pedagogical approach to enhancing student engagement and alleviating learning-related anxiety. This study explored the effectiveness of escape rooms as an instructional tool in geography education, with a particular focus on Generation Z students, who are known for their preference for practical learning opportunities and active engagement.

Results: The study conducted an educational experiment involving Hungarian 7th-grade students, comparing the escape room methodology with traditional frontal teaching methods. The results indicated that students exposed to escape rooms exhibited heightened engagement and sustained attention compared to those in the control group. Furthermore, students generally preferred collaborative escape room sessions, which provided opportunities for social interaction and shared responsibilities. Analysis of end-of-unit test results revealed a positive correlation between escape room methodology and student performance, particularly in tasks requiring higher cognitive levels and evaluation.

Conclusions: The findings suggest that escape rooms align well with the learning preferences of Generation Z students, and contribute to enhanced student engagement, attention, and learning outcomes in geography education. Escape rooms offer a gamified approach that resonates with the characteristics and preferences of modern learners, emphasizing the importance of innovative teaching strategies tailored to contemporary student needs. These insights underscore the potential of escape rooms as an effective instructional tool for fostering meaningful learning experiences.

Keywords: escape rooms, gamification, geography education

Intoduction

In recent years, there has been growing acknowledgment within the educational realm of the efficacy of incorporating games as a pedagogical approach. This paradigm shift has empowered students by providing them with skill-building activities that traditional teaching methods often fail to deliver (Avargil et al., 2021; Peleg et al., 2019; Vidergor, 2021). This study focused on the utilization of escape rooms (ERs) as an innovative educational method. According to Nicholson (2015), ERs are live-action team-based games, in which participants uncover clues, solve puzzles, and complete tasks in one or more rooms to achieve a specific goal, typically escaping from the room within a limited timeframe. ERs are typically dynamic group learning experiences accommodating 2 to 10 participants, though they can also be tailored for individual learners. By combining coop-

eration, collaboration, and hands-on problem-solving, they offer a unique educational opportunity (Arany-Nagy & Jurkinya Mihályné, 2022). ERs in education serve as a method of gamification aimed at motivating students and alleviating the anxiety associated with the learning process (Béres, 2023; Fuentes-Cabrera et al., 2020; Fürjes-Szekeres, 2021). ERs are also an excellent way for learners to grasp the importance of approaching problems from various perspectives. They also provide opportunities for learners to engage in teamwork, build social connections, and foster a sense of fellowship (Panagiotis & Theodoros, 2019; Taraldsen et al., 2022). Additionally, they encourage persistence and engagement while promoting deep learning through group discussions (Hanus & Fox, 2015).

Gamification, particularly teaching through ERs, is methodologically defined by Makádi (2022, p. 42) as "*a teaching-learning strategy in which learners engage in processing curriculum tied to the learning environment, embedded in a story. During interactions and related activities, learners compete with others and face various challenges derived from content or situations. Gamification provides a playful experience enhanced by external elements (scoring system, leaderboard, badges, etc.), differentiating it from didactic games*". Kapp et al. (2013) categorize gamification into content gamification (transforming curriculum to create a game-like experience) and structural gamification (applying game elements to content processing without altering the curriculum, primarily focusing on motivation and engagement through rewards). The authors emphasized that both types of learning could coexist in the same learning process, with their combined application having a more significant impact. The system employed in this study involved structural and content gamification.

The relevance of discussing gamification and ERs in the teaching-learning process arises from the novel and innovative opportunities offered by these tools and methods to enhance the educational experience. Students in primary and secondary education belong to Generation Z, characterized by being born between approximately 1995-1997 and 2010-2012 (Cilliers, 2017; Dolot, 2018; Seemiller & Grace, 2017). This generation has grown in the online world, gaining early and instinctive familiarity with digital tools and online presence, as well as advantages and disadvantages. A defining feature of Generation Z is their ease of access to desired information with only a few clicks.

Seemiller & Grace (2017) argued that the expectations and perceptions of Gen-Z members regarding learning have transformed. However, learning for Generation Z differs significantly from that of previous generations. Northeastern University's innovation survey highlights that Gen-Z students tend to prefer practical learning opportunities that enable them to immediately apply acquired knowledge in real-life situations. One Gen-Z student, as presented in the study, described the ideal learning environment as one where they *"must actively engage to acquire the majority of information"* (Seemiller & Grace, 2017, p. 22). Gen-Z individuals exhibit intolerance toward formal and structured learning, preferring informal and "just-in-time" learning (Carstens & Beck, 2005; Karl, 2007). Under these conditions, gamification and its tools can meet these preferences, making their examination crucial for the design of future schools.

Geography as a school subject

According to Lathwesen & Belova (2021), international studies on interdisciplinary scenarios spanning multiple domains and games rooted in the field of environmental science are absent. In general, there is a discernible deficit of interdisciplinary approaches. Therefore, the geography curriculum in Hungarian public education has the potential to be particularly beneficial to STEM (Science, technology, engineering, and mathematics) research. In the Hungarian education system, geography is fundamentally classified as a natural science subject, yet it possesses several characteristics associated with social sciences. The discipline addresses natural and social geographical issues and knowledge by utilizing methods from natural sciences. Due to the interdisciplinary nature of geography as a school subject, integrating the ER method into teaching methodology is particularly suitable. According to Michael Palin (2011), the former president of the Royal Geographical Society, "*Geography is a living, breathing subject, constantly adapting itself to change. It is dynamic and relevant. For me, geography is a great adventure with purpose*". Geography is unique to all school subjects in its scope for interdisciplinary connections. Geography stands out among school subjects due to its extensive interdisciplinary foundation.

Geography draws extensively from the knowledge and methods of economics, engineering sciences, mathematics, history, sociology, biology, and other disciplines. Consequently, with its diverse foundation, geography can be particularly suitable for developing a wide range of competencies and skills through appropriate techniques and teaching practices (Béres, 2023).

Nevertheless, the popularity of geography remains less than robust among students. Pirkhoffer noted the following: "*From the perspective of students, it is a 'less liked' class. According to surveys that depict the popularity ranking of natural sciences (e.g., Chrappán (2017)), geography is found in the lower half of the ranking, with elementary natural sciences ranking higher. Therefore, as the years progress, something seems to go wrong*" (Pirkhoffer, 2020, p. 109). One reason for this could be the methodological toolkit applied.

According to previous surveys (Bús, 2015; Farsang, 2011, 2014; Schlachter & Teperics, 2022; Ütőné Visi, 2005, 2011), more practical student-centered lessons are infrequently encountered in Hungary. Farsang argues that one of the main reasons for this is that practicing geography teachers suffer from tension caused by the abundance of curriculum content conflicting with limited time frames. Consequently, when various teaching methods are applied, less motivating but less time-consuming frontal methods are used most frequently. The application of more motivating, effective, and time-consuming methods capable of developing skills beyond pure knowledge acquisition is extremely limited (Farsang, 2011, 2014). The number of teaching hours (two per week) allocated to natural science subjects has further decreased in recent years compared with the previous national core curriculum, although their requirements have not fundamentally changed (Farsang & Ütőné Visi, 2020). However, STEM subjects not only provide essential knowledge about how the world functions but also foster critical skills. In addition, they will contribute to future technological advancements and support environmental awareness. The knowledge and skills acquired in these subjects will be important not only

in the labor market but also in stimulating interest in scientific research and discovery, thereby enhancing competitiveness in the job market.

Research Goal

Our objective is to evaluate the effectiveness of ERs as an instructional tool for imparting new knowledge through an educational experiment, focusing on a sample of Hungarian students with average academic performance. In addition to didactic and methodological analyses, we present the established framework and gamified approach to teaching the designated topic based on our thematic plan. We also highlight the observations made within the concurrently conducted parallel control group. The thematic content revolves around Hungary's population, settlement, and economic geography, encompassing a broader perspective. Finally, our goal is to provide a functional framework and an example of ER utilization.

We formulated the following three research questions:

1) Is it possible for students to maintain longer periods of attention during ER learning?

   This study investigates whether the engaging and interactive nature of ERs can extend students' attention spans compared to conventional instructional approaches. We hypothesize that ER learning enhances students' attention spans.

2) Do students prefer collaborative or individual work in the context of ER?

   This research examines whether students prefer collaborative work over individual tasks within ER activities. We hypothesize that the inherent social interaction and cooperative problem-solving in ERs lead students to favor collaborative learning.

3) Does ER align with Gen-Z's learning preferences?

   This study explores whether ER methodologies are compatible with the learning preferences of Gen-Z students. We hypothesize that ERs, with their interactive, practical, and engaging nature, align well with Gen-Z's preference for active and experiential learning, thereby enhancing their overall educational experience.

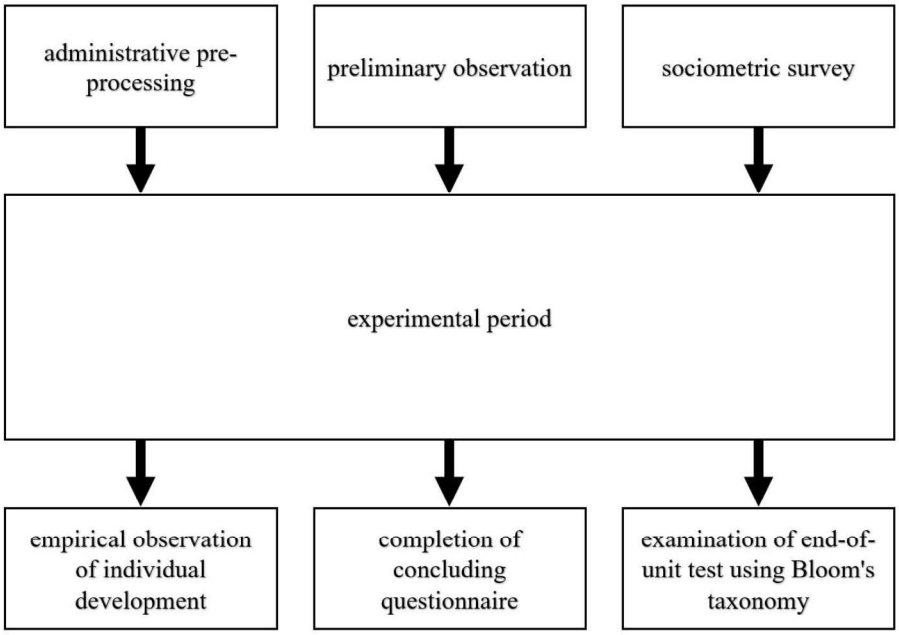
Methods

The procedure of the research

An educational experiment was conducted during the study period (N=46). An educational experiment is an investigation in which the researcher systematically intervenes in the learning and teaching process across multiple variables. Simultaneously, it examines the impact of the intervention on other factors while uncovering and describing the correlations that occur during personality development (Falus, 1993, cited in Csíkos, 2012; Taber, 2019).

This study comprised three distinct phases. Initially, a sociometric examination was conducted to determine how to optimize classroom group work. Subsequently, the experimental period began. Finally, the students demonstrated their knowledge through an end-of-topic test organized according to Bloom's taxonomy, and they completed a concluding questionnaire. The survey comprised seven sections, with the initial part involving students ranking class sessions based on their preferences. Afterward, the participants assessed the classes using a 5-point Likert scale. In the experimental group, questions centered on escape rooms and evaluating preferences and emotions, while the control group addressed a comparable approach but focused on the frontal methodology. The final section involved students providing feedback on learning preferences, including an evaluation by the educator and a closed free-text section.

Figure 1: Flow diagram of the research plan



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Research participants

The participants were Hungarian 7th-grade primary school students. The birth years of students fall within the range of 2009 to 2011, corresponding to their school grade according to the educational system, and all students encountered the curriculum of their respective grade level for the first time.

The experiment involved two seventh-grade classes: a 24-student class (experimental group) and a 22-student class (control group). Both classes were taught on the same topic, with the experimental group using the ER method and the control group employing traditional frontal classroom teaching. The experimental group consisted of 24 participants who were evenly divided into 12 boys and 12 girls. The control group included 22 individuals, 10 boys and 12 girls. In both groups, most participants were urban children.

Study plan

This study was conducted simultaneously in two classes. In both classes, the first seven lessons were dedicated to creating and processing new knowledge, followed by the eighth lesson, which aimed to deepen, review, and reflect on the acquired knowledge. Finally, the ninth lesson served as an assessment and evaluation of the learned material (writing the end-of-unit test). The subject matter covered the geography of Hungary, structured according to the principles of the National Core Curriculum (NAT) and the framework curriculum. The topics were presented consecutively in lessons covering Hungary's population, settlement geography, infrastructure, and primary and secondary sectors of its economy.

As previously mentioned, in the control group, topics were exclusively covered using frontal teaching methods. The organization of these lessons is presented in Table 1.

Table 1: The details of the thematic plan of the control group

Lesson number	Lesson Title	Teaching Method	Utilized Tools
1	Hungarian Population Geography	Frontal Teaching	projector
2	Hungarian Settlement Geography	Frontal Teaching	projector
3	Geography of Budapest	Frontal Teaching	projector
4	Hungarian Infrastructure	Frontal Teaching	projector
5	Hungarian Agriculture	Frontal Teaching	projector
6	Hungarian Energy Industry	Frontal Teaching	projector
7	Hungarian Industry	Frontal Teaching	projector
8	Summary Lesson	Frontal Teaching	projector
9	Closing Lesson	End-of-unit test	-

Source: own source

As shown in Table 1, the pedagogical methodology was exceedingly straightforward, requiring only academic preparation for lessons. The employed methods included teacher narration, illustration, explanation, and lecturing, with the students' only required engagement involving work related to guiding and interpretative questions. A board outline was prepared and presented for each lesson, complemented by teacher dictation, to formulate the final lesson notes in the students' notebooks. Every described concept, process, or knowledge content was explained or presented before the discussion or lecture.

Table 2 presents a simplified thematic plan for the experimental class. The teaching methods applied during the lessons were fundamentally different due to the different ER methodologies.

Table 2: The details of the thematic plan of the experimental group

Lesson number	Lesson Title	Teaching Method	Utilized Tools
1	Hungarian Population Geography	Collaborative Work (Offline)	Worksheet
2	Hungarian Settlement Geography	Pair Work (Digital)	Tablet
3	Geography of Budapest	Collaborative Work (Hybrid)	Worksheet, Tablet
4	Hungarian Infrastructure	Collaborative Work (Digital)	Tablet
5	Hungarian Agriculture	Individual Work (Digital)	Tablet
6	Hungarian Energy Industry	Collaborative Work (Offline)	Worksheet
7	Hungarian Industry	Individual Work (Digital)	Tablet
8	Summary Lesson	Frontal Group Work	Projector
9	Closing Lesson	End-of-unit test	-

Source: own source

Escape room methodology

The concept of escape rooms in education aligns with Nicholson's (2015) definition of ER, which aims to achieve a state of liberation through the solution of puzzles and subtasks that are merely symbolic in an average classroom situation. The experience of an escape room fosters a playful mindset. This is accompanied by a multitude of factors, inducing positive emotions and shifting one's state of consciousness through flow, thereby increasing receptiveness, openness, and creativity. Furthermore, it can expand attention span, enhance cognitive capacity, and improve learning readiness, serving as a powerful modulator of the learning process (Bálint, 2022).

During the creation of the escape room, the educator employs content gamification, as advocated by Kapp et al. (2013), and introduces structural gamification by framing the lessons within a structured framework. Through content gamification, a sense of flow is cultivated during the in-class learning process, attributable to the game-like situation (Csíkszentmihályi, 1990). The purpose of the puzzles and subtasks was to facilitate the understanding and practical experience of the subject matter through situational tasks. The state of liberation essentially corresponds to the completion of all tasks, accompanied by incidental processing of the subject matter. From this point onward, the situation transitions into structural gamification, as it is advisable to reward this "escape". For this purpose, it is recommended to design a gamified system, such as collecting badges or symbols that can be exchanged for grades or other incentives. In this study, a reward framework is organized using a stamp collection system.

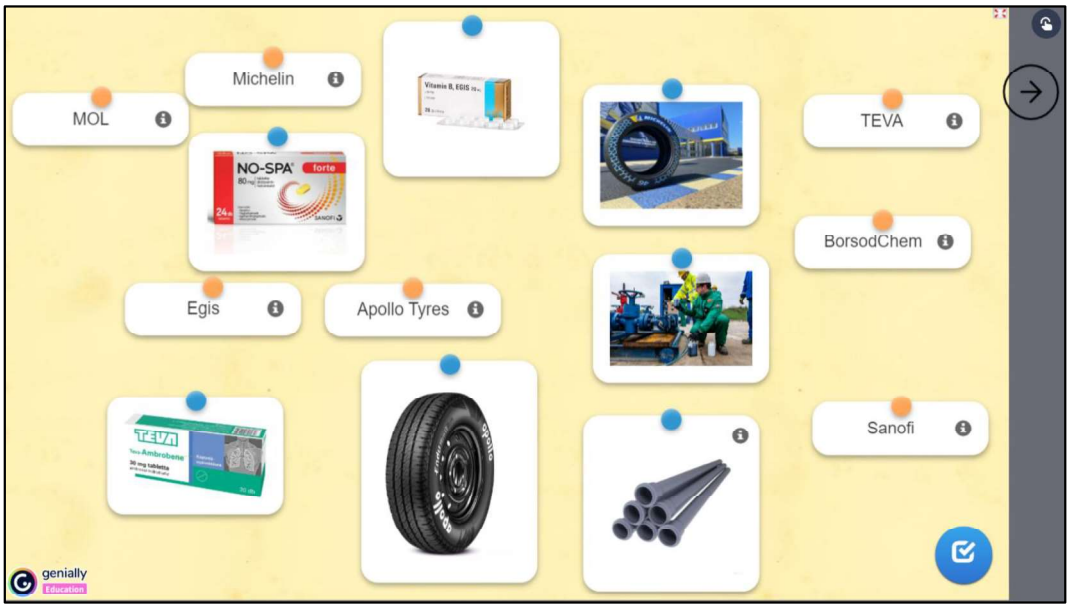
As indicated in Table 2, the ER sessions were conducted in three formats from a technical implementation perspective: digital, hybrid, and offline.

During digital-type lessons, students worked with school tablets. It is important to mention that with the assistance of the school system administrator, we restricted the range of usable applications on each device, allowing only the Google search application and browser to be used as aids.

Digital ERs were designed and executed using the Genially Website (Genially Web S.L., 2023). The platform allows for the creation of interactive ERs, and external content can be embedded. In most cases, we used LearningApps modules. Within Genially's pages, navigation is facilitated by arrows. However, participants obtained a code by solving each embedded task (e.g., 000 or 1111), which the website prompted them to enter upon clicking the arrow. This mechanism requires completion of the task before allowing progression to the next one. The tasks were diverse and included activities such as matching pairs, grouping, arranging events in chronological order along a timeline, short answers, matching data to images, completing missing texts, and solving crosswords. Each task was designed to teach a piece of the lesson and serve its educational and didactic goals. The worksheets aimed to develop the students' competencies in an interdisciplinary manner.

Figure 2 displays a sample task (at the remember level, based on Bloom's taxonomy) in which students had to match some national or significant international companies with the images of their products in a trial-and-error fashion. (In the control group, we projected these images and discussed them using frontal questioning techniques, followed by the creation of a table to organize what they learned). The images were zoomable, but in some cases, they were not clear enough, and later, some corrections to the answers were necessary. Some students took advantage of the trial-and-error approach. When students completed the final task, they were greeted with a closing screen, and could then claim the end-of-lesson reward.

Figure 2: National and international chemical industry companies and a characteristic product



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A hybrid ER methodology was also integrated into thematic planning. The geography of Budapest is examined in this context. First, tasks primarily resembling those found in offline ERs were prepared; then, tasks requiring the application of ICT tools were also included. Digital and auxiliary materials were used in certain tasks. During the lesson, a narrative frame was implemented. At the beginning of the class, an AI-generated video was played, featuring a character who presented himself as Taylor Swift's assistant. Students were asked to guide the characters around Budapest based on Taylor's preferences. Throughout the class, a 40-minute Taylor Swift mix was played. Students particularly identified with the frame narrative and worked completely immersed in the flow (Lien et al., 2019; Vörös & Sárközi, 2017).

In the offline sessions, the work was conducted with the assistance of a comprehensive task sheet. We designed the content of the task sheets to compel students to complete the activities within the framework of microgroup collaborative work. While solving the task sheets, students had to obtain a numerical sequence as a result.

In the case of the offline and hybrid ERs, given that the evaluation was not automated but paper-based, it was challenging for us to determine the appropriate assessment method. Ultimately, we adhered to the original solution, placing correct solutions on a desk in various variations and multiple copies alongside similar but incorrect numerical codes. When generating incorrect numeric codes, we anticipated potential methodological errors by preconceiving possible responses and their underlying reasons. This approach was chosen to align with the class objective, which focused on enhancing students' understanding of the lesson material and developing relevant skills.

Each card, as presented in Figure 3, had a "WIN!" or "NOT A WIN THIS TIME ☹" inscription on the back. If the microgroup decoded the correct number combination, they could flip one of the colored cards placed above them. A puzzle was written on it, allowing students to find the corresponding key according to the color in the classroom. After obtaining the key, the groups had to try all the locks on the four boxes provided, and the boxes that were opened contained the prizes (stamps) for the winners. The lockable boxes served as elements within the ER, symbolizing a physically visible objective.

Figure 3: The final steps in the offline and hybrid ERs: Cards, boxes, and stamps

Source: own source

According to the aspects discussed at the beginning of the chapter, in the experimental class, we offered the opportunity to acquire stamps in every lesson, introducing them as one of the components of structured gamification. The stamps depicted various geographical patterns, such as the sun, a rocket, or a smiling symbol, representing the geography of happiness. If students individually collected four stamps, they could earn a grade five as a reward for their lesson work.

We have made the process of collecting stamps progressively more challenging. The reason for this change was to maintain in-class motivation. On the first occasion, each member of each group could receive a stamp. If a microgroup flipped a card with the correct number sequence for the first time, the entire team could obtain a stamp. However, with each subsequent flip, an individual dropped out of the stamp collection opportunity if their microgroup revealed a card with the wrong combination. In such cases, students discussed and weighted the tasks within the group depending on the number of attempts. Despite the initial incorrect solution, each group member could still receive a stamp. This rewarding procedure helped to sustain the motivation for finding a solution within the group, even if the first attempt resulted in an incorrect solution due to the maintained incentive through grade motivation.

The approach aimed to implement the principle of individual and collective responsibility in cooperative learning (Kagan, M., & Kagan, S, 2009; Arató & Varga, 2008). Collaborative and paired work involves individual tasks and associated responsibility, as well as the principle of shared responsibility, where students check and review each other's subtasks for the sake of collaborative work. According to Fridrich (2023), students actively contribute to discussions, problem-solving activities, and group projects, enhancing their understanding and retention of the material. The students' goal was to ensure that, if everyone contributed significantly, each member could enjoy tangible

rewards. Furthermore, in subsequent lessons, we linked the opportunity to earn stamps to the first three to five finishers in activities such as Kahoot end-of-lesson quizzes.

When creating the thematic plan, we aimed to gradually introduce ERs using various methodological approaches while minimizing stress and building students' self-efficacy for each type of ER. Initially, we organized the students into groups to reduce individual responsibility, thereby minimizing the stress caused by fewer individually performed activities. Table 3 shows the following progression: 1.) The first ER was group-based, reducing individual stress by considering expectations and introducing a new method that was not previously experienced by students. 2.) The first session was offline and aimed at introducing the participants to deductive reasoning. 3.) For offline and/or hybrid ERs, the first two sessions involved collaborative work in 6-member microgroups. For the third session, the number of group members was reduced while maintaining the length of the task. 4.) For digital ERs, we started with paired and three-person group work, then gradually transitioned to individual work after group collaboration.

The summary lesson, featuring a JeopardyLabs game within four large groups (each consisting of five to six members), served a different purpose. This collaborative and frontal approach aimed to accumulate the most points. During this lesson, students could earn the second stamp associated with the gamified assessment system, contributing to the overall stamp collection (eight in total) needed for subsequent perfect scores (Grade 5) in classwork.

Table 3: The evolution of work formats and implementation methods in the experimental group during the development of the ER experience

Lesson Number	Work format				Implementation format	
	Collaborative work - 6 individuals/ groups	Collaborative work - 3 individuals/ groups	Pair work	Individual work	Offline	Digital
1.	x				x	
2.			x			x
3.	x				x	x
4.		x				x
5.				x		x
6.		x			x	
7.				x		x
8	x					x

Source: own source

Findings

End-of-unit test

Bloom et al. (1956) compiled the most frequently used taxonomy system, aiming to assist in defining the objectives of various elements in teaching and learning and identifying associated learning outcomes. By considering and applying this system, educators can better prepare students for higher-level cognitive activities.

The end-of-unit test encompasses all the knowledge required by the students based on the printed notes they received at the end of each ER class. This contrasts the experimental group with the control group, where information was partly presented on whiteboard and partly dictated by the teacher, with students expected to transcribe it into their notebooks.

The individual end-of-unit tests were graded on a 1-5 scale based on the student's performance. We compared these grades with other geographic grades obtained in the same academic year and with previous years' science grades for the same set of students. A moderately strong correlation ($0{,}50 < r < 0{,}71$) was found between the two variables. This indicates a significant relationship between the final grades of previous years and the end-of-unit test, with a positive correlation observed in all instances.

Table 4: Pearson correlation coefficients of the end-of-unit test results with those from previous years

	7th grade: Previous geography grades	End of 6th grade: Science grades	End of 5th year: Science grades
Pearson Correlation	.506	.562	.714
Sig. (2-tailed)	.023	.010	.000

Source: own source

According to these findings, the results of the end-of-unit test were similar to the students' previous performance. This suggests that student performance may be less sensitive to a new teaching method in a relatively short period. Further investigation is required to determine the extent to which these results reflect students' genuine understanding and knowledge of the examined topic. Two relevant studies have reported similar results when examining the achievement of learning objectives through pre- and post-knowledge tests. Neither Cotner et al. (2018) nor Clauson et al. (2019) observed an improvement in academic performance following ER implementation. However, Eukel et al. (2017) concluded that the competitive nature of the learning environment created in the context of ERs may motivate students to study the content, but that knowledge growth cannot be solely attributed to the game.

Table 5: Task averages grouped by Bloom's taxonomy levels

Bloom's taxonomy levels	experimental	control
only remembering	36%	48%
remembering with higher cognitive levels	70%	63%
understanding with higher cognitive levels	47%	52%
only application	81%	80%
only analysis	48%	57%
analysis and evaluation	65%	62%

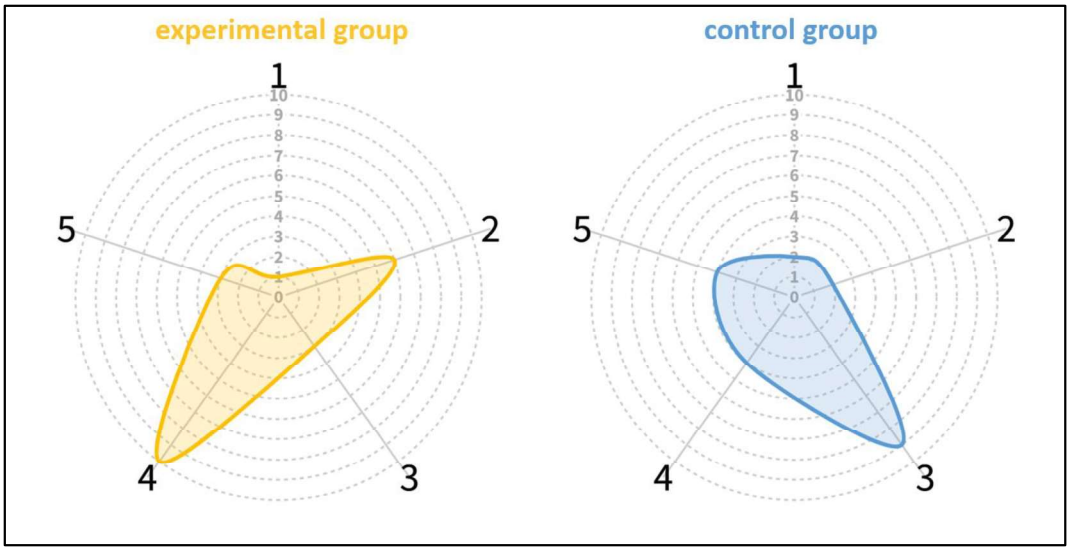
Source: own source

The examination of performance by task according to Bloom's taxonomy allows us to better understand the specific contribution of different teaching methods to students' overall performance. The experimental group demonstrated greater proficiency in higher-order cognitive domains (remembering and higher cognitive levels and analysis and evaluation), suggesting the effectiveness of the intervention in fostering advanced cognitive processes. Conversely, the control group performed well in the foundational (only remembering) and analytical (only analysis) domains. Both groups performed similarly in "only application" category, while the control group showed a marginal advantage in "understanding with higher cognitive levels". These nuanced findings underscore the multifaceted impact of instructional methodologies on distinct cognitive abilities, suggesting that further investigation is necessary to determine the taxonomic levels at which students engage in active learning.

Classroom attention

In the control group, we employed only the frontal teaching method. Thus, preparation for classes took less time, and methodologically, the focus was on a culture of questioning. Despite the methodological simplicity, students reported enjoying the classes. During frontal teaching, due to the lack of constant student activities, students were less able to pay attention during the whole period, as they were not directly involved in the learning process. To assess sustained attention, we asked the following question in the concluding questionnaire: "*I feel I can pay attention throughout the entire lesson*". The results are presented in Figure 4. A score of 1 indicates that the student feels unable to pay attention throughout the entire lesson, while a score of 5 indicates that the student feels able to do so.

Figure 4: Graphical representation of the responses to the question "*I feel like I can pay attention throughout the entire lesson*" by class. (1 = no; 5 = yes)



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A comparative measurement of students' attention retention revealed the following results between the control group (n=21) and the experimental group (n=23): In the control group, 38% of the students marked high scores (4 or 5) in response to the question regarding attention retention, 43% marked medium scores (3), and 19% marked low scores (1 or 2). In contrast, in the experimental group, however, 56.5% of the students marked high scores, 13% marked medium scores, and 30.5% marked low scores. Notably, the distribution of middle scores in the experimental group was asymmetric and right skewed, indicating that most students rated their ability to sustain attention higher.

Popularity of the lessons

The popularity of the lessons was measured by the concluding questionnaire. The results are presented in Table 6. Students were asked to evaluate the lessons using a 7-point Likert scale. The data were analyzed and compared across classes, with percentages color-coded to represent their distribution.

Table 6: Escape room reviews by the experimental group

Lesson number		1	2	3	4	5	6	7
evaluation		frequency [noun]						
least good	1	45%	5%	9%	14%	5%	9%	5%
less good	2	14%	14%	27%	5%	14%	9%	9%
acceptable	3	9%	5%	9%	23%	18%	32%	9%
average	4	5%	18%	9%	14%	9%	23%	27%
good	5	5%	36%	9%	14%	27%	9%	5%
very good	6	9%	14%	14%	18%	14%	14%	23%
best	7	14%	5%	23%	14%	14%	9%	27%
evaluation mode		1	5	2	3	5	3	4

Source: own source

Urban and agricultural geography classes received lower evaluations in both classes, likely due to the curriculum content. In contrast, population geography and infrastructure classes, which offered more practical knowledge, were generally preferred. The infrastructure topic in the experimental group may have been more popular due to its use of less scientific terminology compared to digital ER, making it easier for students to follow.

In terms of ER, the offline sessions covering population geography, the geography of Budapest, and energy industry classes seemed to be the most popular. This was somewhat surprising to us, as we initially expected classes utilizing ICT tools to be more favored.

The methodological variations summarized in the methodological overview aided the students, as indicated by the concluding questionnaire. For statement (E12), "*Over time, I felt the ERs became easier*" the responses had a standard deviation of 0.848. We obtained a mode of 5 on a 5-point Likert scale, with 39% of students rating it as 5, 30.5% rating it as 4, and 30.5% rating it as 3. There were no ratings of 1 or 2, indicating that the students successfully adapted to the new methodology, and began thinking in a deductive, problem-oriented manner over time.

Among the various types of ER, offline ER has shown divisive results, with students evenly marking all values. In contrast, for tablet-supported ER, students reported clear improvements in problem-solving and thinking (Huang et al., 2020; Vass, 2021).

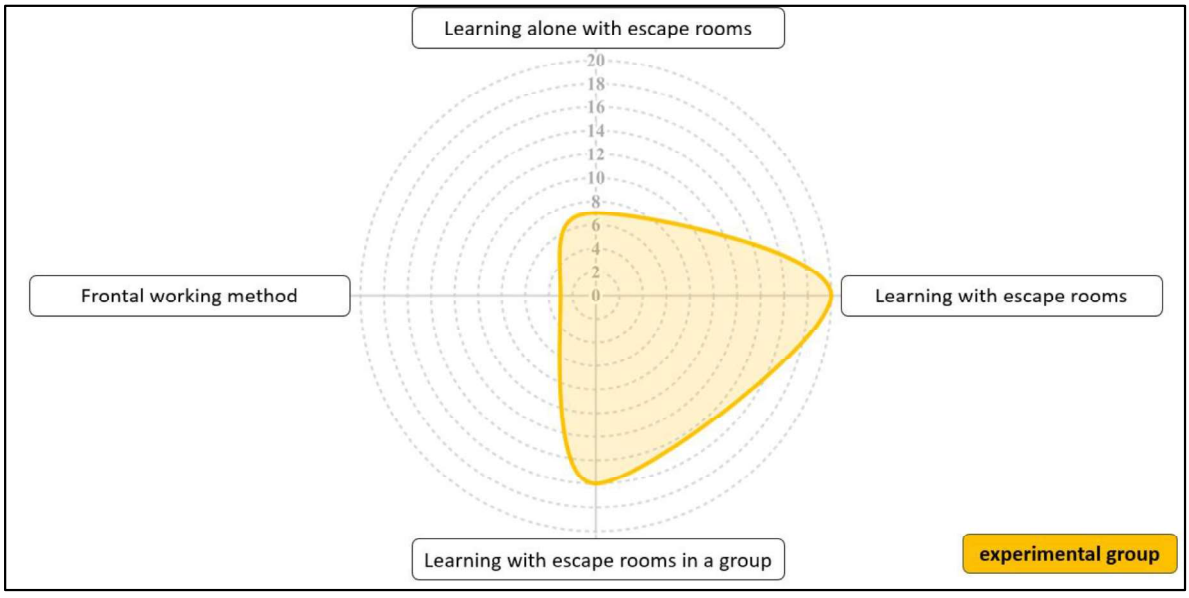
In the experimental group, participants were successful in understanding the different types of tasks, as indicated by their responses to the question (E13), "*I find it difficult to understand the types of tasks in class*". With a mode of 2 and a standard deviation of 1.096 on a 5-point Likert scale, 65% of participants reported no difficulties with the task types, 22% occasionally experienced challenges, and 13% frequently struggled with understanding. These ratios align with the observations, indicating that only two to three participants required additional assistance in interpreting the tasks, including one student with special educational needs.

Students' learning preferences

In the concluding questionnaire, students' learning preferences were examined based on their experiences. Four questions were presented to each group, two of which were similar. They had to choose the one they could better identify with in terms of learning.

In Figure 5, we depict the results of the experimental group's survey. These findings show that the vast majority of students enjoy learning with ER and would continue to learn this way in the future. Students expressed satisfaction from the sense of autonomy, exploration, ownership, and mastery attained during gameplay. It is imperative that educational games are meticulously crafted to facilitate these experiences (Arnab et al., 2015; Barab et al., 2010; Lameras et al., 2017). Regarding the preferred learning format, students tended to favor ER sessions in groups, possibly due to opportunities for social interaction and lower individual responsibility (Forsyth et al., 2002; Weldon & Mustari, 1988).

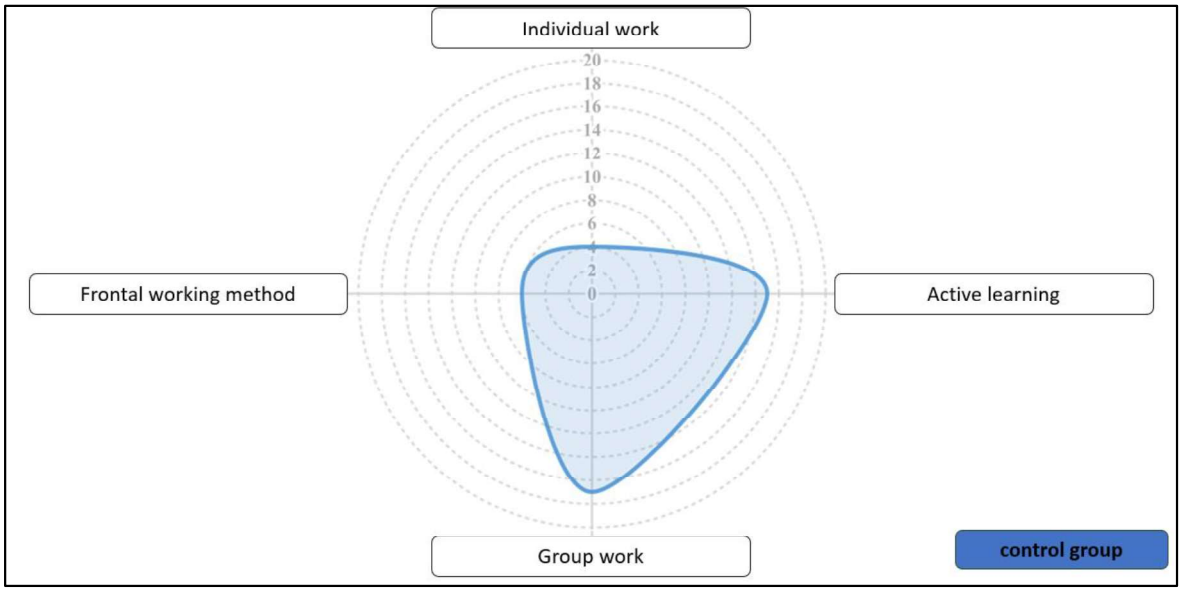
Figure 5: Graphical representation of students' learning preferences in the experimental group



Source: own source

Figure 6 displays the survey results for the control group. Based on these questions, it appears that most individuals in the control group prefer group work in the learning process. Additionally, given the characteristics of Gen-Z, it is likely they would have favored more active learning methods during the experimental period as well.

Figure 6: Graphical representation of students' learning preferences in the control group



Source: own source

Summary and Discussion

The comprehensive results of the study indicate that students in the experimental group, who were exposed to an escape room (ER) methodology, exhibited heightened engagement and sustained attention compared to those in the control group. The concluding questionnaire responses from the experimental group indicated that most students felt capable of sustaining attention throughout the entire ER lesson, suggesting that ER learning contributed to extended periods of concentration among students. This observation aligns with previous research highlighting the enhanced enjoyment associated with ERs (Abdollahi et al., 2021; Peleg et al., 2019; Veldkamp et al., 2021; Watermeier & Salzameda, 2019). Notably, the popularity of lessons, particularly those utilizing offline ERs, increased over time, with students perceiving ERs as progressively easier and indicative of improved problem-solving skills.

The study further revealed that students in both the control and experimental groups generally preferred group work. In the control group, the concluding questionnaire indicated a preference for group work during the learning process. Similarly, in the experimental group, students not only enjoyed learning with ERs but also tended to favor collaborative ER sessions. This inclination toward collaborative work within the context of ERs aligns with the opportunities for social interaction and shared responsibility inherent in such learning environments. The advantages of collaborative work, as recognized in the literature (Barak, 2017; Herrington & Oliver, 2000), were evident in the perceived benefits reported by students.

In certain classroom topics, traditional methods have proven to be more popular among students compared to ICT tools. The findings suggest that topics offering more practical knowledge, such as population geography and infrastructure, were generally preferred. This indicates that practical relevance and relatable content play crucial roles in maintaining student attention. In contrast, topics like urban and agricultural geography received lower evaluations, possibly due to the inherently less engaging curriculum content. The effectiveness of different teaching methods is influenced by both subject matter and desired learning outcomes. While tablet-supported methods have shown promise in enhancing problem-solving and critical thinking skills, they may not be equally suitable for all topics. Paper-based escape rooms, for instance, can offer a tangible and interactive learning experience, particularly when the subject matter is complex or requires hands-on exploration. Students often find these methods engaging and effective in fostering a deeper understanding of the material. Ultimately, the choice of teaching method should be carefully considered based on the specific learning goals and the nature of the content.

The exploration of the results of the end-of-unit test revealed a correlation between ER methodology and student performance, suggesting a positive relationship. Further analysis using Bloom's taxonomy indicated that the experimental group outperformed the control group in tasks requiring higher cognitive levels and evaluation. This finding underscores that ERs not only engage students but also enhance their ability to perform complex, evaluative tasks.

The research findings underscore that ER aligns well with the learning preferences of Generation Z (Gen-Z) students. Gen-Z. Characterized by a preference for practical learning opportunities and an active engagement approach, Gen-Z students responded positively to ER learning. The experimental group not only expressed satisfaction but also indicated a preference for future learning through ER methods, emphasizing the alignment of this innovative and gamified approach with Gen-Z's characteristics and preferences.

In conclusion, the study provides valuable insights, suggesting that integrating ERs into geography instruction enhances student engagement, attention, and learning outcomes. These findings offer important guidance for developing effective teaching strategies tailored to the preferences and learning styles of Gen-Z students.

Limitations

One of the limitations of the present study is its sample size and generalizability. This research focused on a specific cohort of seventh-grade students from Hungary, which restricts the applicability of the findings to a broader population. To enhance the external validity of this research, future studies should employ a larger and more diverse sample across various grades, regions, and educational systems.

Another constraint is the short duration of the experiment. The limited timeframe may not have been sufficient to capture the potential long-term effects of the ER methodologies employed. An extended experimental period is recommended to better understand the sustainability and enduring impact of incorporating ER techniques into student learning.

Another limitation of this study is its focus on geography education. While valuable insights were gained within this domain, the direct applicability of the results to other subjects remains uncertain. To address this limitation, further research should explore the transferability of the ER method to other academic disciplines.

Furthermore, reliance on self-report measures, such as student questionnaires, introduces potential biases into the study. To strengthen the research design, future investigations could benefit from incorporating objective measures and observational data to provide a more comprehensive and reliable understanding of the impact of ER methodologies on student learning.

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