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PAPER

Minecraft Game as a New Opportunity for Teaching Renewable Energy Topics

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ABSTRACT

In today's Public Education Sector, the need for creative education is becoming more and more prominent. An excellent method for achieving this is gamification, which provides an opportunity to activate and motivate students by playfully processing the desired knowledge material. Minecraft is a multi-platform video game that can be successfully used in gamified education. This game platform is used at one of the summer camps we announced for elementary and high school students (10–16 years old). The participants mastered the topics of renewable energy sources with the help of the Minecraft game. This study describes the methods used in the camp and presents the research results on the effectiveness of the camp. The students' current level of knowledge was examined with a questionnaire about renewable energy sources, and the collaborative skills questionnaire was used to assess the collaboration characteristics, and the school creative climate questionnaire was used to explore specific features of the camp. The practical results of the camp and the research results proved that gamification, the use of Minecraft, was excellent for arousing students' interest, increasing their motivation, and helping them master the knowledge materials, effective task solving, and cooperation (i.e., the camp was equally effective from the point of view of knowledge acquisition and collaboration).

KEYWORDS

gamification, Minecraft, renewable energy sources

1 INTRODUCTION

Today's global public education is characterized by methodological renewal. The need to make learning and teaching an experience is increasingly coming to the fore. The roots of experiential pedagogy go back to the work of John Dewey, who believed that the student's experience should be at the center of all teaching-learning processes [1]. The methods based on experience-based learning build on the adequate teaching power of direct experience and make the experiences and learning permanent by processing the subjective experience. Mihály Csíkszentmihályi called the *flow experience* the state when we do not feel obliged to do most of our work because we

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find it exciting and challenging, and difficulties inspire us to find solutions. Solving tasks fills the students with joy and pride, and learning can become an enjoyable adventure in this way. Flow is "the phenomenon when we become so absorbed in an activity that everything else dwarfs it; the experience itself becomes so enjoyable that we want to continue the activity at any cost, just for its own sake" [2].

Gamification enables experience-based learning, using games and game elements, in non-game areas of life, for example, in education [3–5]. Its goal is to make educational processes more interesting and compelling [6]. It arouses the students' curiosity and motivates them with its evaluation system (the classic gamification elements are achieving grades, collecting reward points, competing, and rankings) [7]. In addition to increasing motivation, gamification can be excellently used in the field of education [8–10], for example, to develop logical thinking, and for skill development, for example, developing creativity, problem-solving, and algorithmic thinking [11–13].

Renninger and Bachrach [14] observed and coded the motivations of high school students, and based on these, determined the influences that maintained their attention and motivated them, such as autonomy, challenge, computers/technology, group work, individual activity, the educational conversation, new opportunities, and personal development. Yi et al. [15] investigated the maintenance and development of long-term interest in the STEM field through users of the Minecraft game and concluded that personal relevance played a prominent role in the use of Minecraft. Hughes [16] successfully used the Minecraft program to develop spatial skills in a summer camp for high school students.

2 MINECRAFT IN EDUCATION

Computer and video games are becoming increasingly popular among children, young people, and adults. This is also the case with Minecraft, the world's largest open-world sandbox video game. Educational developers have noticed that the game has 126 million monthly users and that the game's potential can be used well in teaching-learning [17–20]. As a result, the educational version of Minecraft, Minecraft Education Edition, was created, which has a wide tutorial use, a rich technological background, and a toolbox [21].

In the Minecraft game, participants can create new worlds, experiencing the joy of creation, creativity, and discovery. Its virtual world of 3D elements is built from blocks (cubes) that consist of natural and artificial materials, creating the possibility of building and breaking down elements. With the help of blocks, all kinds of objects can be created within the game (e.g., buildings, mountains, plants). The player follows the events from his point of view—he or she can even look around 360° in this virtual world. Participants can play individually or in groups [21]. Minecraft can therefore be used well in various areas of public education (for example, in the field of natural sciences), from 6 years of age to high school [22].

3 IMPLEMENTATION OF EXPERIENCE-BASED TEACHING-LEARNING: EXPERIENCES OF A MINECRAFT CAMP

In the summer of 2022, a unique Children's University Camp was organized within the framework of a university for elementary and high school students (10–16 years old). The goals of the camp were that, on the one hand, the students could learn the basic knowledge related to the use of renewable energy through the

Minecraft game and, on the other hand, using this method would help to develop the students' natural science skills, logical thinking, problem-solving, and an environmentally conscious way of thinking.

One of the camp's aims was to contribute to the training of future engineers by providing insight into some technical and natural science topics and university life. We hope that the participating children would be interested in the technical issues presented and will continue their studies in this field. In other words, the goals of the camp include career orientation.

The camp aimed to develop the following theoretical knowledge and soft skills:

- Strengthening students' environmentally conscious way of thinking
- Developing their scientific skills
- The use of a systemic approach
- The use of electrical and electronic knowledge and its practical application
- Cooperative, collaborative, and independent work in project work
- Basic knowledge of renewable energy sources, combined with green alternatives
- Planning and construction of solar, wind, water, and nuclear power plants in the world of Minecraft
- Gaining experience in urban development
- Critical infrastructure development and a security-conscious approach

Campers were greeted by a pre-generated and revised virtual archipelago, where the creative staff built only their plots and houses and the primary road network for the campers to use. Of course, for the camp tour to meet the set study goals, the area of the power plants built by the campers was also designated, thereby ensuring the dynamics and continuity of the camp concept.

As a result, the campers carried out the necessary preparations for the energy sources or power plants—landscaping, procurement of raw materials, the construction of an additional road network, and connecting the electric transmission line to the network. The fact that on the last day of the camp period, at each predetermined installation point, there was a powerhouse or power park utilizing renewable and alternative energy sources is the merit and pride of the campers since they built and designed the created objects.

A part of the electrical network created in Minecraft was also prepared as part of a practical lab activity by installing a solar energy source, and on the last day of the camp, the participants were able to take part in an excursion where they could visit a solar energy park, so they had the opportunity to compare the solar energy system built within Minecraft to a real and actively producing solar energy facility.

The instructors who transformed the basic game with 50 game-modifying modes gave the constructed Minecraft camp uniqueness, thereby giving the children a virtual experience that reflected, or at least faithfully approximated, reality.

4 RESEARCH ON THE EFFECTIVENESS OF USING MINECRAFT

In order to assess the effectiveness of the camp, we conducted questionnaire surveys:

- On the first and last days of the camp, the students filled out a questionnaire to reveal their current level of knowledge about renewable energy sources.
- On the first and last days of the camp, we assessed the camp's collaboration and "climate" using a questionnaire.

During our research, we hypothesized that the camp would be equally effective regarding knowledge acquisition and collaboration.

4.1 Characteristics of measuring devices

Our questionnaire on renewable energy sources aimed to assess the students' current level of knowledge on this topic. The questionnaire contains ten multiple-choice questions. The idea for the questionnaire came from a quiz for children.

We used a self-developed set of questions to assess the background variables, examine expectations and then experiences related to the camp, and reveal opinions about Minecraft's use.

To assess the specifics of collaboration, we used the collaborative skills questionnaire [23], which provides feedback on how socially competent the respondent is in a group problem-solving situation and how he can cooperate with his peers. The 18-item self-assessment questionnaire, in which the respondents rate each statement from 1 to 7 (1=not typical at all, 7=completely typical), is aimed at measuring social skills, such as action, interaction, effort, adaptive responsiveness, adapting behavior to the partner's needs, negotiation, self-evaluation, peer evaluation, and responsibility. The listed sub-skills belong to three larger skill elements: participation, point of view adoption, and social regulation; they form the three subscales of the questionnaire.

To explore the characteristics of the camp, we adapted the school's creative climate questionnaire [24]. The questionnaire aims to explore the environmental factors that measure creativity. The questionnaire contains 47 statements, grouped into five dimensions: group atmosphere; re-opening; encouraging diversity, autonomy; challenge, interest and limitations, and pressure. Respondents rate each statement from 1 to 7 (1=not typical at all, 7=completely typical).

Fifteen students participated in the camp: 1 girl and 14 boys. Their average age was 11.6 years. The youngest participant was 10; the oldest was 16.

All participants completed the questionnaires. A significant part of the camping students (40%) spend 2–3 hours a day playing computer games, and 33% spend 1–2 hours. In other words, they have significant experience in this field (Figure 1).

No statistically significant correlations were found when examining the relationship with the background variables.

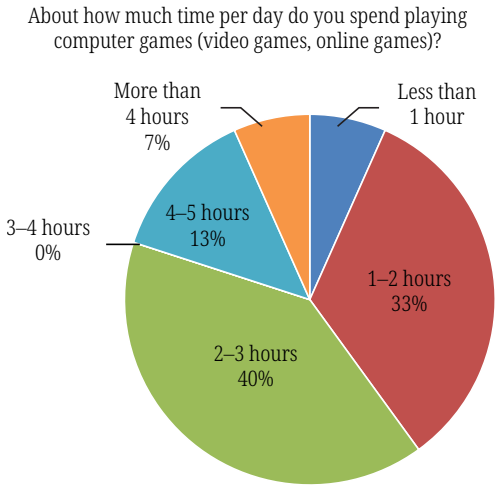

Fig. 1. Assessment of time spent playing computer games (N=15)

4.2 Research results

In Table 1. we present the results of the questionnaires taken on the first and last day of the camp and compare the differences, pointing out the areas where we experienced change.

4.3 Evaluation of the camp

First, we mapped out the expectations related to the camp. The participants primarily expected from the camp that they would have fun, spend their time usefully, participate in exciting laboratory activities, and play and learn with other children.

At the end of the camp, we examined how the initial expectations related to the camp were realized. We found that the students had fun during the camp, spent their time usefully, and played and learned with the other children, which means their initial expectations were fulfilled.

In all but two cases, we received higher average scores on the last day's questionnaire than on the first. The fact that the students found new friends in the camp exceeded their initial expectations to the greatest extent.

Table 1. Expectations related to the camp and their realization (evaluation on a 4-point scale, N=15)

I Expect From This Camp That...	Average	SD	In this Camp...	Average	SD	Difference Between the Averages
I have fun	3.73	0.46	**I had fun**	3.87	0.35	0.14
I will spend my time usefully	3.60	0.74	**I spent my time usefully**	3.80	0.41	0.2
I will find friends	2.73	0.88	**I found friends**	3.20	0.94	0.47
I will learn a lot about renewable energies	3.53	0.64	**I learned a lot about renewable energies**	3.67	0.62	0.14
I will play Minecraft a lot	3.40	0.83	**I played Minecraft a lot**	3.60	0.63	0.2
I can visit an interesting solar power park	3.33	1.11	**I went to visit an interesting solar power park**	3.20	0.77	–0.13
I will listen to exciting lectures	3.27	0.70	**I listened to exciting lectures**	3.33	0.82	0.06
I can take part in interesting lab sessions	3.67	0.49	**I took part in interesting lab sessions**	3.67	0.62	0
I play and learn together with other children	3.60	0.83	**I played and studied together with the other children**	3.80	0.56	0.2

Note: (1 = strongly disagree, 2 = somewhat agree, 3 = mostly agree, 4 = strongly agree).

To further evaluate the effectiveness of the camp, we adapted the school's creative climate questionnaire [24] according to the characteristics of the camp. Here we explored the environmental factors that measure creativity. The questionnaire proved reliable; the value of Cronbach's alpha is 0.90. The respondents gave a highly positive assessment of the fact that the teachers at the camp were interested in what the students thought about a topic, that they encouraged them to find new solutions, and that they felt that learning at the camp was meaningful because they learned a lot of exciting things in the camp by looking for new solutions (Table 2).

Table 2. Examination of the creative climate of the camp (evaluation on a 7-point scale, N=15)

	Average	SD
There is much cohesion among the children in the camp.	5.80	1.37
In the camp, we had the opportunity to listen to each other's thoughts.	6.40	0.99
In the camp, the children often mock and laugh at each other.*	2.07	1.58
In the camp, the teachers encourage us to look for new solutions.	6.60	0.83
We can do only what the teacher says in the sessions.*	6.07	1.16
During the sessions, we have the opportunity to look for innovative solutions to tasks.	6.13	1.13
There is an opportunity to express my opinion at the sessions.	6.27	1.10
The expectations in the camp are realistic.	6.40	0.63
I can speak freely and engage in debate if I disagree with something.	4.47	2.47
What we learned at the camp is not needed in everyday life.*	2.60	1.72
We are often behind in the sessions, so we have to hurry with the task solutions.*	2.67	2.16
They encourage me to find solutions to tasks even after making mistakes.	6.47	0.92
The many rules around me constrain me in the sessions.*	3.27	2.22
I do not use what I learned in the camp in my everyday life.*	2.53	2.07
In the camp, the teachers are open to new ideas.	6.40	0.74
We cannot allow ourselves to make humorous comments during the sessions.*	3.27	2.12
We do not like to play together with the children in the camp.	2.07	1.94
We never use new solutions, only the old ones.*	2.20	1.93
Some tasks can be solved in several ways.	5.20	2.11
We could make independent decisions during the sessions.	4.67	2.26
We have to do the tasks exactly as the teacher wants.*	4.93	1.58
I don't have enough time to think about assignments.*	2.73	2.19
In the camp, the children like each other.	5.87	1.68
I consider learning important.	5.87	1.36
Most teachers don't appreciate humor.*	2.47	1.64
We learn interesting things in the camp.	6.47	0.74
Before deciding, we listen to everyone's point of view and only then decide.	5.53	1.64
I have well-defined goals for my studies.	5.47	1.77
The diversity of my companions in the camp is inspiring.	5.20	1.47
I distrust the other children in the camp.*	2.60	1.99
In the camp, they encourage me to endure the tension caused by an unsolved task.	5.00	2.36
I feel time pressure at work.*	3.67	2.61
In the camp, we are encouraged to think independently.	5.47	1.88

(Continued)

Table 2. Examination of the creative climate of the camp (evaluation on a 7-point scale, N=15) *(Continued)*

	Average	SD
In the sessions, the tasks do not hold my attention.*	2.73	2.43
I feel that we learn important things in the camp.	6.40	1.06
In the camp, the children do not respect each other.*	2.73	2.37
I was often bored in the sessions.*	2.93	2.12
In the camp, the group is unable to cooperate.*	3.40	2.56
Sessions are flexible.	6.40	0.83
Learning at camp makes sense.	6.47	0.92
During the sessions, we do not have time to solve the tasks at our own pace.*	3.40	2.61
I have to do too many tasks in a short time.*	2.47	1.88
The expectations in the camp are not understandable to me.*	2.80	2.51
We don't learn anything interesting in the camp.*	1.73	1.75
There are many personal conflicts between the children in the camp.*	2.27	2.05
The teacher is interested in what the students think about a topic.	6.73	0.46
We always try to look at things from multiple perspectives.	6.13	1.55

Note: *Reverse item. (1 = not at all characteristic, 7 = completely characteristic).

The statements of the creative climate questionnaire are arranged along five dimensions, which form five subscales.

The challenge, interestingness, and meaningfulness subscale show whether the teachers create a challenge for the students. If the student feels that learning is important, exciting, and meaningful and is not boring in class, they will be motivated to learn, which is one of the defining elements of creativity. This subscale also includes the meaningfulness of tasks and commitment to goals.

The dimension of limitations shows the extent to which the student could make his own decisions during his learning process, or he can deal only with what the teacher instructs him to do. In addition to autonomy, this dimension also includes time limits.

The dimension of encouraging openness and risk-taking measures the extent to which students are allowed to look at things from a new perspective, look for alternative solutions, and formulate new ideas without any punishment for making mistakes. Such an atmosphere encourages various intellectual and creative attempts and openness to new things.

The subscale of encouraging diversity and autonomy examines how much teachers encourage students to accept other points of view and opinions and not to judge people with different points of view. If the group is tolerant and accepts diversity, it creates the opportunity to take individual risks and to assume independent thoughts and autonomy.

The group trust and support scale examines the level of acceptance among group members, whether mutual attention is realized, and whether assistance and cooperation are typical. This is important because it creates an atmosphere of trust, and this emotional security is necessary for students to dare to share their thoughts and ideas with other group members [24].

In our research, the dimension of openness proved to be the strongest; the camp supported the students in being open to new things, examining emerging questions from a new approach, and trying new things. The camp was a challenge for the students and limited them little in their autonomy, and the absence of a time limit was not typical either. (Figure 2).

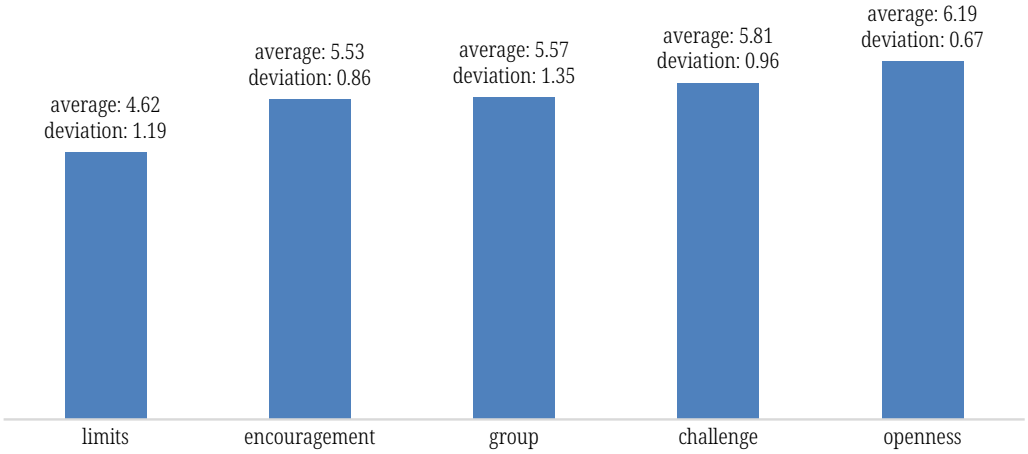

Fig. 2. Dimensions of the camp's creative climate (N=15)

4.4 Change in knowledge level

To map the students' current level of knowledge in the field of renewable energy sources, the students filled out a questionnaire consisting of 10 multiple-choice questions on the first and last days of the camp.

Questions related to previous knowledge (e.g., What is the source of energy on Earth?, What is renewable energy? Which is one of the primary sources of renewable energy? What is not a renewable energy source?, Which type of fuel produces an immense amount of energy? Which fossil fuel does gasoline come from? Which renewable energy source provides the most energy in Hungary?) contained thought-provoking, practical, and topical questions (e.g., What consumes the most electricity in an average Hungarian home? How much electricity does a Hungarian home consume on average in a year? What consumes more energy: using our laptop (6 hours) or making coffee with the coffee maker (15 minutes)?

We found that the students' knowledge level increased during the camp. While on the first day, the percentage of correct answers among campers was 47.33%; on the last, it was 56%. Regarding the individual questions, the percentage of correct answers was 47.33% on the first day and 60.67% on the last. The improvement rate for each group is 8.67%, considering individual questions it is 13.33%.

It is important that knowledge about renewable energy and increasing environmental awareness be given a more prominent role in public education [25], [26]. In Hungary, students primarily learn about the energy economy, energy use, and the energy crisis, as well as geothermal energy and hydropower [27]. It is necessary for students to get to know the possibilities of renewable energy sources more thoroughly so that they deal more with the issues of energy consumption, intended energy use, and energy efficiency. That is why we considered it essential to teach this topic playfully at the camp.

4.5 Experiences with the Minecraft program

86.67% of the respondents were used to playing Minecraft at home; 27.67% at a friend's, relative's, or acquaintance's; and 6.67% at school, in a class, or in the workshop (there are respondents who have played in multiple locations). Before the camp, every child knew this game.

In the questionnaire taken on the first day of the camp, the participants answered that what they like best about Minecraft is that you can solve tasks, realize your ideas, and play together with others. In education, these motivational factors can be used to the best advantage, so students can solve different tasks in a playful environment while being creative and cooperating with other students.

The tremendous success in the camp was the large-scale and experience-influencing modification expansion because the children felt the game had gained a new meaning by transforming the basic game. They liked that they could solve tasks, and this game relaxed them.

The most significant positive difference between the initial experience with Minecraft and the application in the camp is that in the camp they were able to solve tasks better, learned more from it, and got to know better how to modify the real world (Table 3).

Table 3. Evaluation of the application possibilities of Minecraft (on a 4-point scale, N=15)

	What I Love About Minecraft is That...		What I Liked About Minecraft During the Camp was That		The Difference Between the Averages
	Average	SD	Average	SD	
you can play together with others	3.60	0.83	3.53	0.92	–0.07
you can build a new world of your own	3.40	0.74	3.67	0.72	0.27
I can realize my ideas in it	3.67	0.62	3.47	0.74	–0.2
the graphics are good	2.87	1.13	3.20	0.94	0.33
you can learn a lot from it	2.93	0.88	3.40	0.91	0.47
I can solve tasks	3.13	0.92	3.87	0.35	0.74
it provides good relaxation	3.73	0.46	3.87	0.35	0.14
it models the real world	2.80	1.01	3.20	0.94	0.4
Minecraft takes on a whole new meaning with so many modes			3.93	0.26	

Note: (1 = strongly disagree, 2 = somewhat agree, 3 = mostly agree, 4 = strongly agree).

4.6 Assessment of collaboration

We used the collaborative skills questionnaire [3] to explore the characteristics of collaboration. We investigated how the respondent could cooperate with his peers in group problem-solving situations.

The questionnaire proved reliable (Cronbach's alpha value was 0.91 for the first and 0.85 for the last day's questionnaires).

On the first day of the camp, we asked the participants to recall situations in which they had to solve some class or extracurricular task or project in pairs or

larger groups and then try to determine how typical the given statements were for them. The most characteristic of the respondents is that when they work in a group, they usually try to solve their partial task until they succeed, they respond to the suggestions of the others, and they try another strategy to solve their partial task if the previous one did not work.

The data from the questionnaire taken on the last day of the camp revealed that the participants knew what kind of work they are best suited for; they try to solve their tasks until they succeed and can easily see if they are not right.

The most significant positive difference in the assessment of the previous group work and the group work in the camp can be seen below: in the camp, the students made suggestions on what task to do to a greater extent, and they found a familiar voice with everyone and shared their ideas with their peers better (Table 4).

Table 4. Examination of collaboration (evaluation on a 7-point scale, N=15)

	When We Work in a Group, Most of the Time...		When we Work in Groups at the Camp, Most of the Time...		The Difference Between the Averages
	Average	SD	Average	SD	
I actively participate in work.	5.93	1.28	5.67	1.18	–0.26
I respond to other people's suggestions and proposals (e.g., with approval and questions).	6.00	1.56	5.87	1.19	–0.13
I try to solve my sub-task until I succeed.	6.20	0.94	6.00	1.00	–0.2
Listening to the suggestions of my peers, I get a good idea.	5.73	1.33	5.80	1.01	0.07
I find common ground with everyone	4.40	1.26	5.07	1.49	0.67
I can easily see if I'm not right.	5.73	1.10	6.00	1.00	0.27
I know what kind of work I am best suited for.	5.80	1.26	6.20	0.94	0.4
I suggest who should do what task, according to what they are good at.	4.47	1.88	5.20	2.08	0.73
I also monitor how my group mates get on with their work.	5.33	1.80	5.67	1.76	0.34
I am active.	5.80	1.77	5.87	1.46	0.07
I share my ideas and thoughts with my colleagues.	5.40	1.88	5.93	1.39	0.53
I'd try another strategy to solve my sub-task if the previous one didn't work.	6.07	1.16	5.13	1.85	–0.94
I will further develop one of my colleagues' ideas.	5.20	1.47	5.40	1.40	0.2
I can explain my ideas in a way that everyone can understand.	5.07	1.67	4.93	1.79	–0.14
I will try to reconcile the parties if there is a disagreement.	5.00	1.51	5.13	1.64	0.13
I indicate if I think the division of labour should be changed.	5.33	1.84	4.80	2.04	–0.53
I help my colleagues after finishing my work.	5.27	2.12	5.47	1.51	0.2
I will tell you if I disagree with someone.	4.87	1.81	4.73	2.25	–0.14

Note: (1 = not at all characteristic, 7 = completely characteristic).

The statements of the collaborative skills questionnaire belong to three larger skill elements: participation, point-of-view adoption, and social regulation, which form the three subscales of the questionnaire.

The Participation subscale characterizes the student in terms of how involved he is in work, whether he responds to the initiatives of his peers, whether he initiates interactions himself, and how much effort he puts into solving a given group task.

The Point-of-View subscale provides feedback on the extent to which the student is open to the suggestions of his peers: he rejects, accepts, or perhaps even develops them further. He also examines whether he can shape his communication in such a way that others can accept it and whether he is receptive to the needs of his group mates.

The Social Regulation subscale measures how well the respondent can form a compromise; whether he can assess his strengths and weaknesses and keep them in mind when choosing a task in the group; whether he sees the abilities of others and takes them into account when assigning tasks; and whether he feels a personal responsibility for the group to complete its task [23].

For comparison, data from a large sample (N=2128) from an earlier study of eighth graders can be used as a basis [23]. Since only one girl participated in the camp, we did not analyze our data by gender.

We found that the Minecraft camp had significantly higher scores than in the previous large-scale study. This indicates that the participants in the camp were characterized by harmonious cooperation that worked very well. The students made efforts to solve the tasks, were open to the ideas and suggestions of their peers, and felt personal responsibility for the group solving the assigned tasks.

In the questionnaire taken at the end of the camp, except of one scale (participation), higher average scores were obtained than on the first day of the camp in the evaluation of the previously completed group work, which indicates that the collaboration was very well realized in the Minecraft camp, although the students' activity could have been enhanced and they could have been better encouraged to try another strategy to solve the sub-tasks if the previous one did not work (Table 5).

Table 5. Comparative examination of collaborative abilities
(own research: N=15; research by Pásztor-Kovács et al.: N=2128)

	General Group Work (First Day)		Group Work in the Camp (Last Day)		Study by Pásztor-Kovács et al. (2020)	
	Average	SD	Average	SD	Average	SD
Collaborative skills (full scale)	97.80	17.62	98.87	14.68	boy: 86.91 girl: 89.95	boy: 17.30 girl: 16.43
Participation subscale	35.40	6.09	34.47	3.70	boy: 29.45 girl: 30.96	boy: 6.60 girl: 6.43
Point-of-view subscale	20.40	3.62	21.20	3.61	boy: 19.34 girl: 19.97	boy: 4.33 girl: 4.20
Social regulation subscale	42.00	9.46	43.20	9.44	boy: 38.13 girl: 39.02	boy: 7.86 girl: 7.61

5 SUMMARY

Our study presented the experiences of a summer camp organized by our university, which introduced elementary and high school students (ages 10–16) to the various aspects of renewable energy sources in a playful way. In the camp, the students built their virtual world using the game called Minecraft, constructing power plants based on renewable energy sources as part of their city's energy supply and maintenance systems. The camp can be considered unique, because the game was expanded, with more than 50 game-modifying modes, giving the children a virtual experience very close to reality. In addition to technical innovations, the Minecraft camp was characterized by many methodological innovations. To assess the effectiveness of the camp, we carried out questionnaires on the first and last days, which were primarily aimed at revealing the current level of knowledge about renewable energy sources, the collaboration taking place in the camp and the "climate" of the camp. Based on the results, we determined that the application of Minecraft was effective in arousing the students' interest, increasing their motivation, mastering of the knowledge material, and effective task solving and cooperation. The research confirmed our hypothesis: the camp was effective in knowledge acquisition and collaboration.

We can use the experiences of the camp in planning and preparing for next year's summer Minecraft camp, focusing on proven, fertile areas (such as collaboration) and continuing to improve areas with a lower rating (such as activity levels).

The results of the camp can also be used in education; for example, in the fields of STEM (science, technology, engineering, mathematics). It is often complex for students to learn difficult science subjects, but they can learn the curriculum by playing with the Minecraft application.

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