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STEAM LEARNING AS A BASE FOR DEVELOPING COMMUNICATION SKILLS IN INCLUSIVE SCHOOLS

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Abstract. *This research addresses the problem of how to tackle STEM education and its transformation into STEAM education in an inclusive school. It highlights the need for communication competence in collaborative teaching supported by problem-based (PBL), project-based (PrBL) and game-based (GBL) learning. At the same time, it is necessary to highlight the importance of arts in all the listed innovative forms of learning and teaching, as teamwork and cooperation between the members of these teams are extremely important. The key competence of this participation in the mentioned forms of knowledge is communication competence, which is manifested in students' self-confidence/lack of self-confidence, in their level of well-being, collaboration, motivation, their active role and awareness.*

The empirical research was conducted on a sample of eleven classes from six Slovenian-inclusive schools, with at least one student with SEN in each class. The research focused on the differences between students with and without SEN regarding their perception of STEAM lessons supported by gamification elements. The results showed that using innovative teaching methods can connect and positively affect STEAM, which, with the help of technology, engineering and art, consequently, improves a deeper understanding of the field of Science and Mathematics (S-tea-M).

Keywords: *communication skills, collaboration-based learning, game-based learning, inclusive school, innovative learning environment, special educational needs (SEN)*

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Introduction

Inclusivity in today's contemporary schools is fundamental for science, technology, engineering and mathematics (STEM) education and is not just about addressing specific barriers but also about creating common learning environments for all (Wade et al., 2023; Hutain & Michinov, 2022, Lamanauskas, 2024). Inclusive education for people with SEN is often framed in terms of human rights or justice, but the economic dimension for educating people with SEN is also very relevant. Lack of appropriate education remains the key risk factor for poverty and exclusion of any person, whether they are disabled or not. One of the critical Europe 2020 targets is to have at least 20 million fewer people in or at risk of poverty and social exclusion. In addition, the fourth of the 17 Sustainable Development Goals stated in the UN 2030 Agenda for Sustainable Development is 'Guaranteeing equal and accessible education by building inclusive learning environments and providing the needed assistance for persons with disabilities'. Various research (Flogie, 2016; Wyman, 2018) has shown that with different learning strategies and methods of learning and teaching, such as problem-based learning (PBL), project-based learning (PrBL), research-based learning (RBL), game-based learning (GBL) and cooperative learning, better results can be achieved, especially in areas which require a deeper understanding, such as STEM (Lamanauskas, 2024). Figure 1 shows the content and didactical approach of a lecture on renewable energy, which can be an example of how to integrate different sciences within STEM into a complete, coherent whole (Aberšek & Flogie, 2022).

The term STEM and its variations have been widely used across educational settings (Fomunyam, 2020). Research on STEM education has gained attention as a result of the poor performance of children from the United States in international competitions in science, engineering, and mathematics, as well as the low number of children pursuing careers in these STEM fields (Flogie, 2016). Other countries, such as the United Kingdom, Finland, Germany, and Canada have developed national strategies to promote STEM education of children (Hutain & Michinov, 2022). STEM pedagogy has demonstrated effectiveness in promoting engagement, persistence, problem-solving skills and competences, and active learning through exploration, observation, and discovery (MI1, 2022). STEM pedagogy also promotes development in

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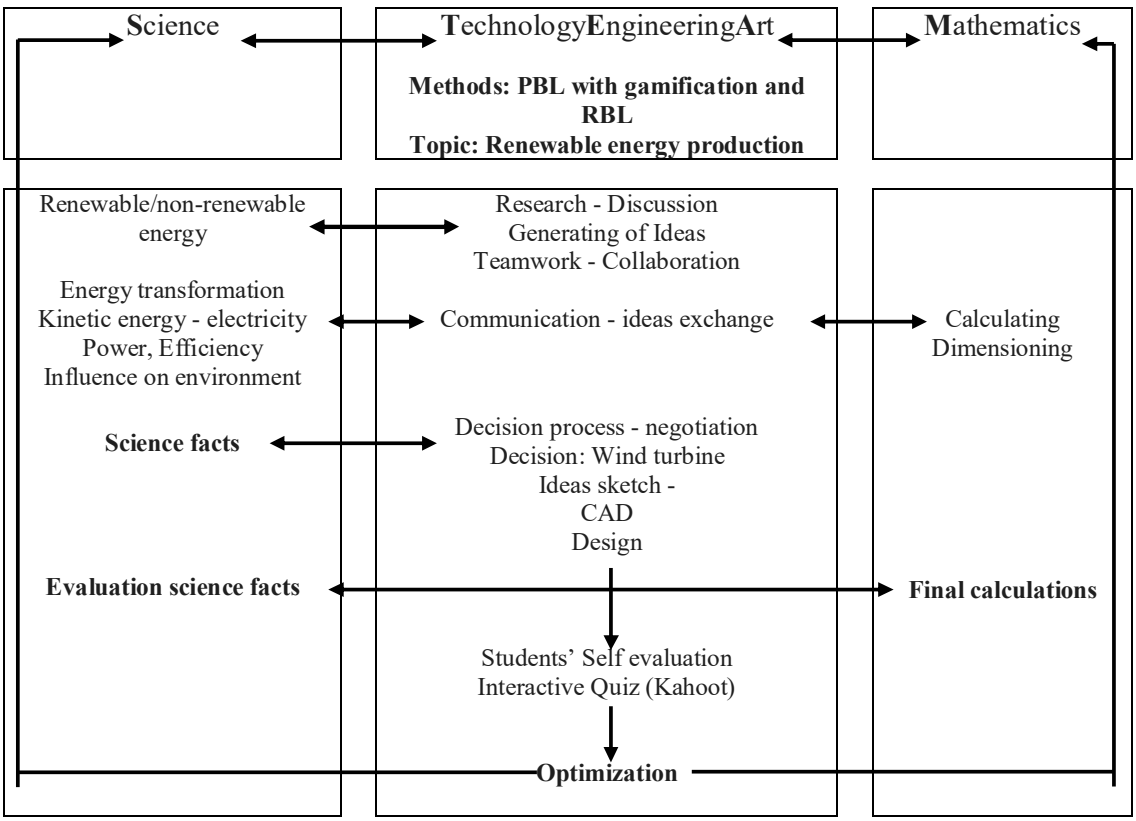
areas of *language acquisition*, *literacy, comprehension*, and *communication skills* (Kordigel Aberšek & Aberšek, 2022). Additionally, research supports the idea that engagement in the arts enhances children's learning skills, including creative and strategic thinking skills, and allows children to explore patterns, use measurement tools, use various digital tools for visualization in space and to stimulate visual imagination, to design products and perform calculations (Šrot & Duh, 2023; Šrot, 2019).

Therefore, art has since been incorporated into traditional STEM pedagogy, and the acronym STEM has evolved into STEAM. Wade et al. (2023) point out that promoting of equity and access to learning science for all children is critical in early childhood settings, especially in inclusive schools. In order to promote access to STEAM pedagogy in inclusive school settings for students with or without disabilities, educators need to be intentional about their practice. With the help of PBL, PrBL, RBL, GBL cooperative learning, and interactive tools such as educational applications, multimedia content and adaptive learning platforms, students, especially SEN students (each of them is different, with different needs!), can be offered a more customized and engaging learning experience (Aberšek, 2018; Hutain & Michinov, 2022, Lamanauskas, 2024). At the same time, it is also necessary to highlight the importance of the arts in all the listed innovative forms of learning and teaching. For all of them, teamwork and cooperation between the members of these teams is essential (Deng, et al., 2024). Moreover, the key competence of this participation in the mentioned forms of learning is communication competence, which is manifested in students' self-confidence (or lack thereof), in their level of well-being, collaboration, motivation, their active role and awareness (attitudes), which are discussed in the presented research (Šrot et al., 2023).

Figure 1

*STEAM lecture: Correlation between **S**cience, **T**echnology, **E**ngineering, **A**rt and **M**athematics on the example of renewable energy production*



When discussing communication, it should be pointed out that communication always occurs on both, the verbal and the non-verbal level. Under various non-verbal forms, in addition to body language, graphic expressions are also considered, which can be expressed with the help of various pictograms, emojis, pictures, sketches and drawings and other elements of the visual code such as colour, lines, shape, composition (Šrot & Duh, 2023;

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Šrot, 2019), which significantly connects STEM with STEAM. A similar coexistence of verbal and non-verbal code is observed in GBL, where one of the key elements is learning environments based on gamification. In GBL learning environments, the use of graphic and visualization elements is key, especially when posing a wide variety of real problems, which are by definition complex, challenging to understand and demanding, as in the example shown in Figure 1 on the extremely topical field of renewable energy sources.

In the STEAM field, the importance of teamwork and cooperation is increasingly highlighted, whereby communication is the key to understanding the problem and defining ideas based on which one can arrive at final solutions. Within STEAM, the fields of science and mathematics are particularly demanding, especially in primary and lower secondary schools, as they also require in-depth understanding, which can be indirectly achieved with PBL, PrBL or RBL (Aberšek, 2018) by concretizing the problem within the field of technology, engineering and art, thus relating it to concrete sub-problems which are easier to explain, and which can help to make sense of the more abstract part of the problem. However, to achieve this in the learning process when using PBL, PrBL or RBL, the key is developing collaboration competencies, language acquisition, comprehension, and communication skills. The latter are particularly problematic for SEN students, as they prefer not to expose themselves due to past failures in communicating with their peers in the PBL or PrBL group. The problem of timid students who do not know how to communicate in a team and thus do not participate in "solving the problem" in PBL is also observed in some mainstream students. However, in the case of SEN students, even more complex differences have been reported regarding cooperation, an active role in PBL or PrBL, or in the attitude towards STEAM. Concrete activities in the context of technology, engineering and art can have a positive effect on the attitude towards science and mathematics, which in turn also improves the attitude and in-depth understanding of abstract concepts in the field of science and mathematics (S-tea-M), for example, the content of renewable energy production, symbolically shown in Figure 1 (Aberšek & Flogie, 2022).

Game theory helps to understand how and why people make certain decisions and how those decisions affect outcomes for everyone involved. In education, gamification may include elements of competition and cooperation that encourage students to develop strategies to achieve goals together. In addition, gamification with appropriate visualizations or simulations (part of art and STEAM) can deepen the understanding of abstract elements. This can increase engagement and collaboration among peers and encourage critical thinking and decision-making (Darina et al., 2015, Flogie et al., 2018).

Innovative schools, innovative teaching and innovative learning environments are thus important concepts in modern-day education. Such approaches are an attempt at transforming yesterday's (today's) education systems by incorporating effective teaching methods and a meaningful and effective use of modern technologies, which improves learning outcomes and better prepares all students for the future. Innovative teaching involves creating a learning environment which places students in an active role, at the centre of the learning process (Niemi et al., 2022). An important focus of innovative teaching and learning is the development of competences that are required for successful living and working in the 21st century (Fomunyam, 2020).

In recent years, digital technology has played a vital role in the design and improvement of learning environments, mainly due to its ability to personalize learning and adapt to the needs of individual students, which is especially important in today's inclusive schools, where we have students with special educational needs (SEN) and mainstream students in the same learning community. Innovative teaching methods and innovative learning environments allow teachers to differentiate, individualization and personalization and to adapt teaching materials and learning methods to the individual abilities and interests of students, which is especially useful for SEN students (Bazler & Siele, 2019; Wade et al., 2023).

Slovenian schools are inclusive schools, which means that they accept diversity and create conditions for the social inclusion of all children and young people. That is why the organization of a systematic transfer of knowledge, which can consider the specifics of the individual (including children with SEN), is one of the key issues of inclusive education. Inclusive school policy focuses on ensuring equal opportunities, advancement, equal participation of everyone involved, and social justice. The fundamental value of Slovenian inclusive schools in the education of SEN children is the focus on the individual child or youth and their development. SEN children and young people are provided with additional forms of assistance through a "SEN guidance decision", where individual characteristics of the child are taken into account (MI1, 2022). The basic principle of inclusion is based on human rights and captured in international documents and in the laws of many countries. In Slovenia, this area is regulated by several legal provisions, including the Placement of Children with Special Needs Act (MI2, 2022).

The implementation of a program for groups of SEN students is adapted in such a way that the same learning objectives are maintained. According to their developmental and learning abilities, SEN children are able to achieve

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at least the minimum standards of knowledge specified in the curricula, with the help of adapted implementation and additional professional help and specialist services. Primary and lower secondary school education is compulsory in Slovenia and lasts nine years (children aged six to fifteen). It is carried out by public and private primary schools and institutions for the education of SEN students.

In the education of SEN students, innovative learning environments are of utmost importance, since they can increase student engagement, as they include the use of new technologies, new approaches and methods to improve the learning process (Flogie, 2016; Wade, 2023). Such environments encourage students' interaction, collaboration, and active involvement, and enable flexibility and adaptation to individual student's needs, which in turn helps to improve the quality of education (Tomar & Garg, 2021). The personalization of learning environments supported by digital technology not only enables SEN students to have easier access to education, but also promotes their cognitive and social development and the development of skills necessary to successfully face life's challenges. This approach exploits the potential of each student to a maximum and creates a more inclusive and equal learning environment for all (Bazler & Van Sickle, 2019).

Research Problem

In Slovene inclusive schools, mainstream students and students with special educational needs (SEN) participate in the same learning communities/classes. However, they require different didactic approaches, especially in the abstract areas of science and mathematics that require in-depth understanding. The model shown in Figure 1 proposes the adoption of relevant knowledge and understanding with the help of concrete activities within the framework of technology, engineering and art (sTEAm) using communication skills, in a rounded multidisciplinary and interdisciplinary circle of STEAM philosophy.

Forms of work that allow for collaboration and communication between all classmates and the teacher enable more permanent knowledge in STEAM, as they encourage active participation with communication (discussion, presentation and exchange of ideas, decision making) in the learning process, which includes both emotional and mental engagement (Marentič Požarnik, 2003).

Research Focus

This research is based on PBL and collaborative learning, with game-based learning (GBL) in STEAM education as a central teaching approach. GBL in education can provide practical, experiential learning opportunities that promote deeper understanding and permanence of knowledge (Alsagaaf & Li, 2022). In GBL learning environments, the use of graphic and visualization elements is key, especially when posing a wide variety of real and complex problems. Gamification is not directly based on a single philosophical or theoretical concept, but rather involves several theoretical frameworks and disciplines. Some of the key concepts that support the idea of gamification are: behaviourism, motivational theory, positive psychology, constructivism, game theory, and the experiential learning theory.

Collaboration-based learning and developing emotional intelligence (Aberšek, 2018) are also important components of gamification. Collaborative learning is a key part of social competence and refers to an individual's ability to effectively and appropriately participate and communicate in various social situations. Collaborative learning may include group work, discussions, role-playing, peer learning, problem-based learning, etc. In collaborative learning, all students in the group contribute to the development of their own skills as well as the skills of the other members of the group, and, in the process, develop and/or enhance various social skills (Cenclj, 2019, 2020). Adolescents face various challenges during schooling that affect their self-confidence and their mental and emotional well-being. Many studies indicate the positive use of gamification elements to promote participation in the learning process. A study on the use of modern digital tools with elements of gamification, which was conducted among primary school students in Sri Lanka, reported, among other things, positive effects of gamification elements on student participation in collaborative work (Halloluwa et al., 2018).

Research Aim and Research Hypotheses

This research describes the use of an intentional framework, universal design for learning (UDL), to plan for and implement STEAM teaching and learning process in the inclusive classroom (Bazler & Van Sickle, 2019). The research deals with the effects of introducing gamification in innovative learning environments, which enhances

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motivation, collaboration and communication competence among SEN and mainstream students. In the empirical part, an innovative, personalized and gamified approach (see Figure 1) was implemented at six Slovenian schools, researching the attitude towards gamification supported by the use of modern technology, and its effect on the learning of SEN and mainstream students.

In the context of this research, a learning approach using gamification in the process of adopting curricular materials/content from the field of STEAM and renewable energy production was explored, which focuses on the use of gamification elements in teaching and on the attitudes of students towards technology, exploring an active role, motivation, collaboration and participation. Based on an overview of literature and findings, the following hypotheses were formulated:

H1. There are statistically significant differences in collaboration and active role between SEN students and mainstream students when the learning approach contains elements of gamification.

H2. The use of gamification in lessons on renewable energy production increases the participation, communication and active role of SEN and mainstream students.

H3. The use of gamification in lessons on renewable energy production is positively correlated to the motivation for collaboration of SEN and mainstream students.

Research Methodology

General Background

This research addresses the problem of STEAM education in inclusive schools. It highlights the need for communication competence in collaborative teaching supported by a problem-based and project-based approach and gamification. The research is based on the gamification method as a central teaching approach. Gamification in education can provide practical, experiential learning opportunities that promote deeper understanding and permanence of knowledge. Gamification is not directly based on a single philosophical or theoretical concept, but rather involves several theoretical frameworks and disciplines. Some of the key concepts that support the idea of gamification are: behaviourism, motivational theory, positive psychology, constructivism, game theory, and the experiential learning theory. These serve as the basis for the study of key elements such as motivation, collaboration, and the active role of students.

Sample

The research was conducted in a real learning environment on a sample of six primary schools, three from urban and three from rural areas. 11 departments, in which there was at least one SEN child, were included in the research. A total of 155 students of the second and third triad (from the third to the ninth grade) participated, of which 27 were SEN students. In this research, the children who have been issued a decision on the status of a person with special needs "SEN guiding decision by the regulations of the Slovenian Ministry for Education (MI1, 2022)" are treated as SEN students. Purposive and convenience sampling methods were applied. Departments with at least one SEN student were included purposefully.

The questionnaire (online quiz) for students' self-evaluation was previously tested in cooperation with experienced experts ($N = 22$), such as principals, special pedagogues, social workers and teachers.

Table 1
Department, Total Number of Participating Students, and Number of SEN Students

Triad	Grade	Number of students	Of which SEN students
2	5	13	2
	6	15	5
	6	16	4
	6	10	1
	6	18	1

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Triad	Grade	Number of students	Of which SEN students
3	7	15	2
	7	15	2
	8	16	5
	8	12	2
	8	10	1
	9	15	2
	Total	155	27

Instrument and Procedures

A quantitative methodology was used to test the hypotheses. During the preparation and adaptation of the teaching methods, an instrument, questionnaire for students' self-evaluation in the form of interactive online quiz using a gamification tool (Kahoot) was developed to collect data on the implementation of the lesson, which was used to compare the collaboration, active role, motivation and attitudes of students towards STEAM when introducing elements of gamification in the form of an online quiz. (Urhahne &Wijnia, 2023).

The questionnaire (online quiz) for students' self-evaluation was previously discussed and tested in cooperation with experienced experts, such as principals, special pedagogues, social workers and teachers (sample of experienced experts = 22). The reliability of the questionnaire was determined by a reliability test, which shows the value of Cronbach's coefficient α. The questionnaire consisted of a 4-point Likert scale, where 1 meant "not true" and 4 "very true". The calculated value of Cronbach coefficient α was 0.725, which is more than the necessary condition α = .7 to confirm the reliability of the 4-point scale and the entire questionnaire (Garcia Lopez et al., 2023).

Purposive and convenience sampling methods were applied. Classes with at least one SEN student were included purposefully. The STEAM lesson (see Figure 1) was conducted as part of the subject Technical Education (technology, engineering and arts – sTEAm) using the innovative teaching method and with the use of digital technology and mobile learning with elements of gamification (use of an interactive online quiz – Kahoot). With the help of a questionnaire/quiz, the students self-assessed their activity, motivation, collaboration and achievement of learning goals after the implementation of the innovative problem-based form of work compared to the traditional, frontal implementation of the lesson.

Data Analysis

Data analysis was based on descriptive and inferential statistics. Hypotheses were tested with a t-test for independent and a *t*-test for dependent samples and with the Pearson correlation coefficient. Cohen's d, which measures effect size, was also used. Based on the results of the students' self-evaluation, data was collected and statistically processed using the SPSS software.

To test the hypotheses, the results of descriptive statistics were compared between the group of SEN students and the group of mainstream students. A *t*-test for independent samples was used to determine whether the arithmetic means of the two groups differed statistically significantly for each question. A paired *t*-test was used to determine the connection between motivation and student activity in both groups of students. Next, the connection of various variables according to the group of students was determined.

Research Results

From the descriptive statistics, it can be seen that the students accepted the lessons supported by gamification elements positively, as the average values on a scale from 1 (not true) to 4 (very true) are between 2.88 (*SD* .875) and 3.65 (*SD* .5999). The students believe that they participate more actively in lessons where gamification elements are included, they feel good and they like working with gamification elements. The results are presented in Figure 2.

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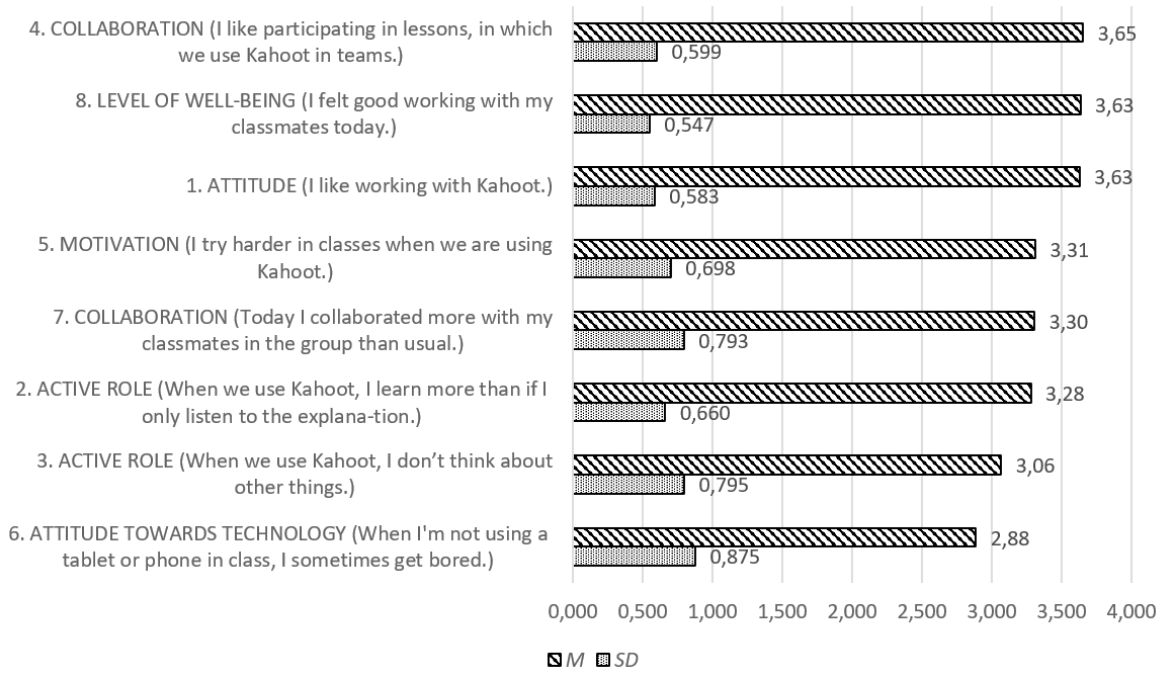
Figure 2
Graphical Representation of Descriptive Statistics



The first hypothesis, which posits that "there are statistically significant differences in collaboration and active role between SEN students and mainstream students when the learning approach contains elements of gamification," was verified by dividing the data into two groups, SEN students and mainstream students. A comparison between these two groups (Table 2) showed that SEN students play a more active role in learning and collaboration when gamification elements are present in the lessons ("2. ACTIVE ROLE When we use Kahoot, I learn more than if I only listen to the explanation.") (M =3.30, SD = 0.669) than mainstream students (M = 3.27, SD = 0.661), although this difference is not statistically significant (p = .871), the effect size is medium (Cohen d = .662). SEN students are more likely to get bored during traditional face-to-face lessons (M = 3.15, SD = 0.818) than mainstream students (M = 2.83, SD = 0.823), compared to lessons including digital technology ("6. ATTITUDE TOWARDS TECHNOLOGY When I'm not using a tablet or phone in class, I sometimes get bored"). The difference is statistically significant at a 10% risk (p = .084, and α = .1). The results also showed that SEN students participated more in the lesson than usual when the lesson contained elements of gamification (M = 3.56, SD = 0.577) ("7. COLLABORATION Today I collaborated more with my classmates in the group than usual.") compared to mainstream students (M = 3.25, SD = 0.823), which indicates an improvement in their participation and a more active role in the lesson. This difference is also statistically significant at a 10% risk (p = .069 and α = .1). Therefore, lessons supported by elements of gamification are in principle very beneficial for SEN students.

The results, with a weak statistically significant difference (10%), indicated an increased active role of SEN students and their motivation for work and collaboration, in lessons supported by the gamification method.

Mainstream Students, compared to SEN students, reported being more concentrated on average (M = 3.13, SD = 0.774, compared to M = 2.78, SD = 0.847) when using Kahoot because 'they are not thinking about other things when using it'. This difference is also statistically significant (p = .039 and α = .05), and the effect size is relatively large (Cohen's d = .787). This can be interpreted from the perspective that SEN students already have more trouble focusing and communicating than mainstream students. It can be concluded on this basis that forms of work in the classroom, which involve PBL, digital technology and elements of gamification, benefit them. Regardless of the group of students, they all agreed (M = 3.27 (without SEN) and M = 3.30 (with SEN)) that they learn more from lessons including elements of gamification, as compared to frontal instruction, they try harder (M = 3.33 (without SEN) and M = 3.22 (with SEN)), and they feel good about collaborating with classmates (M = 3.64 (without SEN and M = 3.59 (with SEN)).

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Table 2
Descriptive Statistics and t-test for Independent Samples

Statements	Student	Descriptive statistics			t-test for independent samples		
		N	*M*	*SD*	Sig. (2-sided *p*)	*MD*	*SD* error dif.
1. ATTITUDE I like working with Kahoot.	0	128	3.66	0.565	.075*	.220	.123
	1	27	3.44	0.641			
2. ACTIVE ROLE When we use Kahoot, I learn more than if I only listen to the explanation	0	128	3.27	0.661	.871	-.023	.140
	1	27	3.30	0.669			
3. ACTIVE ROLE When we use Kahoot, I don't think about other things.	0	128	3.13	0.774	.039**	.347	.167
	1	27	2.78	0.847			
4. COLLABORATION I like participating in lessons, in which we use Kahoot in teams.	0	128	3.70	0.538	.075*	.296	.161
	1	27	3.41	0.797			
5. MOTIVATION I try harder in classes when we are using Kahoot.	0	128	3.33	0.677	.476	.106	.148
	1	27	3.22	0.801			
6. ATTITUDE TOWARDS TECHNOLOGY When I don't use my phone or tablet during classes, I sometimes get bored.	0	128	2.83	0.879	.084*	-.320	.184
	1	27	3.15	0.818			
7. COLLABORATION Today I cooperated more with my classmates in the group than usual.	0	128	3.25	0.823	.069*	-.306	.167
	1	27	3.56	0.577			
8. LEVEL OF WELL-BEING I felt good working with my classmates today.	0	128	3.64	0.557	.680	.048	.116
	1	27	3.59	0.501			

Note: Key: 1 – SEN students, 0 – mainstream students; *correlation is statistically significant for .05; ** correlation is statistically significant for .01

Analysis using a paired *t* - test (Table 3) showed statistically significant differences between groups of students according to their responses to certain pairs of questions from the questionnaire. For mainstream students, a statistically significant difference was observed in the responses between the attitude towards technology (6. "When I don't use my phone or tablet during classes, I sometimes get bored") and the active role of students (2. " When we use Kahoot, I learn more than if I only listen to the explanation"), and between attitudes towards technology and collaboration (7. "Today I cooperated more with my classmates in the group than usual"). These findings indicate differences in attitudes towards technology and the effectiveness of using gamification elements in lessons. This suggests that mainstream students experience Kahoot as a tool that increases their collaboration and active role in classes, especially in the context of group work and interaction with technology.

For the group of SEN students, statistically significant differences were detected in pairs: active role (2. ACTIVE ROLE When we use Kahoot, I learn more than if I only listen to the explanation) and collaboration (7. COLLABORATION Today I cooperated more with my classmates in the group than usual), motivation (5. MOTIVATION " I try harder in classes when we are using Kahoot") and collaboration (7. COLLABORATION Today I cooperated more with my classmates in the group than usual), and attitude towards technology (6. ATTITUDE TOWARDS TECHNOLOGY When I don't use my phone or tablet during classes, I sometimes get bored) and collaboration (7. COLLABORATION Today I cooperated more with my classmates in the group than usual). These findings suggest that the use of gamification elements has a significant impact on the active role of students in group work, their motivation for learning and collaboration with classmates, especially for SEN students.

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Table 3
Paired t-test for SEN Students and Mainstream Students

Pair	Statements		Descriptive statistics			Paired t-test		
			M	*SD*	*SE*	*t*	*df*	*p* (two-tail)
1	2. ACTIVE ROLE When we use Kahoot, I learn more than if I only listen to the explanation and 5. MOTIVATION I try harder in classes when we are using Kahoot.	0	-0.055	0.724	0.064	-0.854	127	.395
		1	0.074	0.730	0.140	0.527	26	.602
2	2. ACTIVE ROLE When we use Kahoot, I learn more than if I only listen to the explanation and 7. COLLABORATION Today I cooperated more with my classmates in the group than usual.	0	0.023	0.951	0.084	0.279	127	.781
		1	-0.259	0.594	0.114	-2.267	26	.032*
3	5. MOTIVATION I try harder in classes when we are using Kahoot and 7. COLLABORATION Today I cooperated more with my classmates in the group than usual.	0	0.078	0.884	0,076	1.000	127	.319
		1	-0.333	0.734	0,141	-2.360	26	.026*
4	6. ATTITUDE TOWARDS TECHNOLOGY When I don't use my phone or tablet during classes, I sometimes get bored and 2. ACTIVE ROLE When we use Kahoot, I learn more than if I only listen to the explanation.	0	0.445	0.903	0.080	-5.578	127	<.001**
		1	-0.148	0.949	0.183	-0.811	26	.425
5	6. ATTITUDE TOWARDS TECHNOLOGY When I don't use my phone or tablet during classes, I sometimes get bored and 7. COLLABORATION Today I cooperated more with my classmates in the group than usual.	0	0.422	0.936	0.083	-5.100	127	<.001
		1	-0.407	0.844	0.162	-2.508	26	.019

Note: Key: 1 – SEN students, 0 – mainstream students; * correlation is statistically significant for .0; ** correlation is statistically significant for .01

In the following step, we observed whether there was a correlation between gamification in lessons and students' collaboration and active role (hypotheses 2 and 3), comparatively for the group of SEN students and the group of mainstream students. The correlation was determined using the Pearson correlation coefficient.

Table 4
Correlation Between Gamification and Students' Responses

	Student	1. Attitude	2. Active role	3. Active role	4. Collaboration	5. Motivation	6. Attitude towards technology	7. Collaboration	8. Level of well-being
2. Active role	0	.480**	1						
	1	.399*	1						
3. Active role	0	.277**	.333*	1					
	1	.047	.198	1					
4. Cooperation	0	.498**	.297	.297**	1				
	1	.460*	.198	-.259	1				
5. Motivation	0	.270**	.414**	.267***	.335**	1			
	1	-.125	.519**	.146*	.33	1			
6. Relation	0	.168**	.339**	.020	.58**	.386**	1		
	1	.90	.198	.382*	.022	.241	1		
7. Cooperation	0	.080	.192*	.173	.240**	.318**	.397**	1	
	1	.139	.553**	.183	.325	.471*	.308	1	

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	Student	1. Attitude	2. Active role	3. Active role	4. Collaboration	5. Motivation	6. Attitude towards technology	7. Collaboration	8. Level of well-being
8. Well being	0	.239**	.141	.142*	.298**	.398**	.194*	.386**	1
	1	-.013	.374	.141	-.050	.426	.153	.547**	1

Note: Key: 1 – SEN students, 0 – mainstream students; * correlation is statistically significant for .05; ** correlation is statistically significant for .01

The correlation coefficient values across the two groups showed that there is a more even, statistically significant correlation between active role, collaboration, motivation, attitude towards technology and well-being in mainstream students than in SEN students.

However, for SEN students, the correlation is statistically significantly higher between the student's active role when using gamification "When we use Kahoot, I learn more than if I only listen to the explanation", and their motivation to learn " I try harder in classes when we are using Kahoot".

Motivation and collaboration for SEN students correlate statistically significantly higher compared to mainstream students, which emphasizes the powerful impact of motivation on the participation, active role and well-being of SEN students in this group.

A statistically significant difference between the responses of SEN students to question 6 "ATTITUDE TOWARDS TECHNOLOGY When I don't use my phone or tablet during classes, I sometimes get bored," and 3 "ACTIVE ROLE When we use Kahoot, I don't think about other things" showed that the use of advanced digital technology with SEN students helps to improve their focus on collaboration and concentration during lessons. It also reduces their feelings of boredom when they are removed from traditional forms of teaching. This result demonstrated the effectiveness of using innovative learning aids supported by gamification elements to increase communication, collaborations and engagement between students and reduce distractions for SEN students, which is crucial for improving their learning experience, their learning outcomes and for promoting their inclusion in the educational process.

The correlation between collaboration *"Collaboration: Today I cooperated more with my classmates in the group than usual"* and level of well-being *"Level of well-being: I felt good working with my classmates today"* was also statistically higher in SEN students, which suggested that improved collaboration and positive feelings when working with classmates further contribute to a more effective learning process and better communication in the group.

Discussion

The STEAM lesson (see Figure 1) was conducted innovative teaching method with the use of digital technology and mobile learning with elements of gamification (use of an interactive online quiz – Kahoot). With the help of a questionnaire/quiz, the students self-assessed their activity, motivation, collaboration and achievement of learning goals after the implementation of the innovative problem-based form of work (Aberšek, 2018).

The results of this research showed that collaborative learning methods based on PBL and gamification in the STEAM teaching/learning process have a positive impact on collaboration in both groups of students – SEN students and mainstream students, with the correlation stronger for some variables in the group of SEN students. Many other authors, such as Darina et al. (2015), Chen et al. (2022) and Deng, et al. (2024), have observed similar positive effects of using gamification on motivation and collaboration. The findings of this research showed that the correlation between collaboration and the active role of SEN students – when the STEAM lessons were supported by elements of gamification – was statistically significantly stronger compared to mainstream students (Bazler, & Van Sickle, 2019). This confirms the hypothesis that gamification has a positive effect on inclusion and collaboration, especially for SEN students. The statistically significant correlation between the use of gamification and motivation, as well as improved collaboration, indicated that elements of gamification can be used as an important tool to promote the motivation and involvement of SEN students. It also contributes to a higher level of well-being in a group of children and to better collaboration (Alsaqqaf, & Li, 2022).

This research was focused on finding out whether there were statistically significant differences in collaborations and active role between SEN students and mainstream students, in lessons containing elements of gamification. Although the results showed a slightly greater active role and collaboration in SEN students compared to mainstream students, in lessons supported by gamification, these differences are not statistically significant

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(Tomar & Garg, 2021). This suggests that the use of gamification elements can be similarly efficient for both groups of students, which is somewhat contrary to our expectations (that gamification would have a significantly greater effect on SEN students). It is necessary to consider the fact that this research covered a relatively small number of SEN students. Conclusions formed based on a larger sample would, of course, be more valid. However, the effect size (Cohen's *d*) was larger in the group of SEN students, which indicated the importance of these findings in a practical sense, despite the difference not being statistically significant.

From the results, it can be inferred indirectly that with increased motivation, collaboration and active role, the STEAM learning outcomes of SEN students improve more whenever the lessons include elements of gamification. These findings are consistent with the results of many other studies. García López found that the inclusion of gamification elements in existing digital learning aids increases the level of student satisfaction and improves learning outcomes (Garcia Loperz et al, 2023). Similarly, a study conducted among primary school students found a positive impact on learning outcomes when using modern digital tools which contain elements of gamification (Nand et al, 2019).

The results of this research confirmed that the use of gamification in teaching is consistent with motivational theory, experiential learning theory and the principles of behaviourism, which indicates its effectiveness in promoting motivation, engagement and collaboration between students, especially those with SEN (Flogie, et al., 2018). When interpreting the results of this research about the impact of gamification on STEAM learning processes in SEN students, it is important to consider certain limitations that may affect the generalization of the findings. An important limitation of the study is the relatively small sample of SEN students, which may limit the generalization of the results onto a wider population. Smaller samples can also cause greater variability of results and less reliable statistical tests. Another limitation is the use of only one gamification technology, i.e., focusing exclusively on the use of an interactive quiz (Kahoot) as a gamification tool may limit the understanding of how other gamification tools and approaches would affect the research results.

For further research, it would be advisable to work with a larger sample of SEN students, to include different types of disabilities, and to investigate a demographically more diverse sample, which would allow for a better generalization of the results and their applicability to a wider population of students.

Based on the obtained results, the recommendation to teachers working with SEN students is to use innovative learning methods such as PBL, PrBL and collaborative-based learning and to include digital technologies with elements of gamification in their classes, to improve engagement (active role) and collaboration among students.

Conclusions and Implications

An inclusive school is the foundation for creating an environment which enables *all students*, regardless of their individual needs, to participate and cooperate in the educational process as *equally as possible*. Contemporary digital technologies, especially those containing elements of gamification, play an important role in the transformation of learning environments and methods into more innovative ones which support differentiation, individualization and personalization.

Based on the presented theories and the example of renewable energy production, which represent the theoretical framework for collaborative learning with gamification, key aspects of the learning process were investigated, such as motivation, collaboration and personalized learning, with the participation of students from six Slovenian schools. This approach has allowed us to gain important insights into how collaborative learning with gamification can enhance the educational experience for students with or without special needs, and how it can serve as an effective tool to enrich the learning process (especially groups of SEN students).

Based on the results, it was found that SEN students believe that learning with modern teaching aids, which is more interesting than traditional (frontal) teaching, makes them feel more motivated, and they participate to a greater extent and more enthusiastically in the group (which they would otherwise not). The developed teaching model has proven to be useful in primary and lower secondary schools, especially in *inclusive schools* and in classes with SEN students, who require more personalized learning and adapted forms of work.

In the future, an even greater integration of digital technologies in inclusive schools can be expected, with an emphasis on the development of applications and platforms that are adapted to specific learning needs. This will not only enable a more personalized learning experience for each student, but also encourage greater autonomy and independence in learning. The presented didactic model is not only related to STEAM education as one of the most demanding forms of integration but is also applicable in all other learning areas with appropriate adaptations.

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Declaration of Interest

The authors declare no competing interest.

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