Exploring the Effectiveness of Game-Based Learning in Teaching the 2030 Agenda to Middle School Students

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Abstract. This experimental research aimed to investigate the use of a board game for improving argumentation and counter-argumentation skills related to the 2030 Agenda in middle school students. The study involved two different classroom conditions, one where a board game was used, and another where a frontal lesson was held using slides. Pre-test and post-test questionnaires were administered to investigate the students' interest and knowledge of the 2030 Agenda before and after the experience. Each student was then asked to write an argumentative essay, about their favorite topic of the 2030 Agenda, illustrating the reasons why it was important for them.

The results showed that the board game condition led to higher interest and better learning outcomes than the frontal lesson condition, but both conditions showed significant improvement in interest and knowledge of the 2030 Agenda. This highlights the importance of developing argumentative and counter-argumentative skills in middle school students and the potential of games as practical tools to make learning more engaging and effective.

The findings also suggest that there should be a synergy between traditional teaching approaches and innovative approaches such as games to improve learning outcomes. Future research could explore the long-term effects of such interventions and the potential of games for improving other soft skills in students. Overall, this study contributes to the growing literature on the effectiveness of games for education and highlights the importance of incorporating innovative approaches in education to improve learning outcomes.

Keywords: Gamification · argumentation and counter-argumentation skills · 2030 Agenda

1   Introduction

In recent years, gamification has become an increasingly popular approach to learning, particularly in educational contexts. Gamification refers to the use of game design elements and principles in non-game contexts, such as education, to motivate and engage learners. In particular, gamification has been shown to be effective in enhancing learning outcomes by improving students' motivation, engagement, and knowledge retention.

According to Deterding et al. (2011), gamification refers to the use of game design elements, such as points, levels, and rewards, in non-game contexts, to motivate and engage learners. Gamification has also emerged as an innovative and engaging approach to improve learning outcomes in various educational settings.

The development of argumentation and counter-argumentation skills has been identified as a critical aspect of academic success and life-long learning (Kuhn and Udell 2003). These skills enable individuals to effectively communicate their ideas, evaluate evidence, and engage in critical thinking Dawson and Venville 2010). Several studies have explored the effectiveness of argumentation-based approaches in enhancing students' critical thinking and reasoning skills (Bromme et al. 2011; Hmelo-Silver et al. 2007; Osborne and Patterson 2011).

Gamification and argumentation-based approaches share a common goal of enhancing students' engagement and motivation in the learning process. By integrating gamification elements into argumentation-based activities, educators can create an engaging and challenging learning environment that fosters the development of argumentation and counter argumentation skills. According to Koivisto and Hamari (2019), gamification can enhance students' motivation and engagement in learning, leading to improved learning outcomes. Similarly, Dawson and Venville (2010) suggested that argumentation-based approaches can promote students' engagement and participation in the learning process.

Several studies have investigated the potential of gamification in improving argumentation and counter argumentation skills in various educational settings. For instance, Huang et al. (2017) found that a gamified argumentation-based learning approach improved students' argumentation and critical thinking skills in a college-level course. Similarly, Borges et al. (2018) reported that a gamified online discussion platform enhanced students' argumentation and collaborative skills in a university-level course. These findings suggest that gamification can be an effective tool for enhancing argumentation and counter argumentation skills in higher education.

However, few studies have explored the potential of gamification in improving argumentation and counter argumentation skills, or soft skills generally, in middle school students. Lee et al. (2019) underline how gamification has the potential to support middle school students' engagement, motivation, and learning outcomes, emphasizing the potential of gamification as a tool for improving science education in middle school, while Chen et al (2019) investigated the effects of a gamified argumentation approach on middle school students' argumentation performance and cognitive load., using a gamified argumentation system called Game-based Argumentation Instruction (GAI) and compared its effectiveness with a non-gamified argumentation approach. Results showed that students in the experimental group had significantly better argumentation performance and lower cognitive load than those in the control group, proving that the

gamified approach is an effective way to enhance middle school students' argumentation skills.

Given the importance of developing soft skills, such as argumentation and counter argumentation skills, in middle school students, it is critical to investigate the potential of gamification in enhancing these skills in this age group. The present study aims to fill this gap by investigating the effectiveness of a board game on improving argumentation and counter argumentation skills in middle school students.

By developing argumentative and counter-argumentative skills, middle school students can better understand the complexities of the world around them, communicate their ideas effectively, help to think critically, reason logically, and engage in productive discourse with others (Kuhn and Udell 2003, p. 1245). These skills are essential for success both academically and professionally, making it crucial to incorporate them into middle school education. Teaching argumentation skills to middle school students is important because it can help them to understand complex issues, think critically about the world around them, and communicate their ideas effectively to others (Dawson and Venville 2010, p. 464).

Soft skills are essential for success in academic, personal, and professional pursuits, and it is important to foster their development in children from a young age. In recent years, gamification has emerged as a practical tool to interest children in learning while promoting the development of important skills such as problem-solving, critical thinking, and collaboration. However, it is important to note that gamification should not replace traditional lessons completely. Instead, there should be a synergy between the two approaches, with gamification being used as a supplement to traditional teaching methods. By combining these two approaches, students can benefit from the engaging and interactive nature of games while also receiving the foundational knowledge and skills necessary for academic success. In this study, we sought to explore the potential benefits of incorporating gamification into traditional lessons and the importance of balancing the two approaches to achieve optimal learning outcomes for middle school students.

One of the key areas where gamification has been applied is in the context of sustainable development education. Sustainable development education is a critical area of education, particularly given the current global environmental challenges. The United Nations has recognized this by adopting the 2030 Agenda for Sustainable Development, which sets out a comprehensive framework for global sustainable development. The 2030 Agenda includes 17 Sustainable Development Goals (SDGs), which are aimed at ending poverty, protecting the planet, and promoting prosperity for all.

Given the complexity of the SDGs and the need for broad-based public engagement in their implementation, it is essential to develop innovative and effective educational approaches to promote awareness and understanding of the SDGs. One promising approach is gamification, which can help to engage and motivate learners, and promote the development of important skills such as critical thinking, problem-solving, and collaboration.

Therefore, the present study aims to investigate the effectiveness of a gamified approach for teaching the 2030 Agenda to middle school students. Specifically, the study will focus on the use of a board game designed to improve argumentation and counter-argumentation skills related to the 2030 Agenda. The study will compare the effectiveness of the board game approach with a more traditional frontal lesson approach. By doing so, the study will provide valuable insights into the potential of gamification as an effective educational tool for the development of soft skills, such as argumentative and counter-argumentative skills, and for a sustainable development education, and contribute to the broader literature on gamification in education.

2 Method

2.1 The Game

The board game used in this study was inspired by "Summit 2030" (Ligabue et al. 2016) but was modified to place a greater emphasis on debate and argumentation skills. In the modified game, participants were required to make and defend their arguments while also responding to opposing viewpoints. The game consisted of several rounds of debate on different aspects of the 2030 Agenda, and the winner of each round was determined based on their ability to make and defend their arguments effectively. By using this modified game, the study aimed to foster the development of argumentation skills and to promote interest in the 2030 Agenda among middle school students.

2.2 Participants

The study involved 44 middle school students, with 22 students in each class. All students were from the same school and were in the same grade: second grade of middle school.

2.3 Design

A pre-test/post-test control group design was used to evaluate the effectiveness of a board game on the development of argumentative and counter-argumentative skills, as well as on the students' interest in the 2030 Agenda.

2.4 Measures

Two different types of measures were used: a multiple-choice test to assess the students' prior knowledge and interest in the 2030 Agenda, and an argumentative essay assignment to evaluate their argumentative and counter-argumentative skills. The multiple-choice test consisted of 8 questions, with 4 questions related to prior knowledge and 4 questions related to interest in the 2030 Agenda. The essay assignment asked students to write about their favorite topic from the 2030 Agenda and provide a justification for why it was an important point of the Agenda for them.

2.5   Interventions

The study involved two interventions: a board game and a frontal lesson. The board game intervention was designed to promote the development of argumentative and counter-argumentative skills, as well as to increase students' interest in the 2030 Agenda. The frontal lesson intervention served as a control condition. Each intervention lasted one hour, and both were conducted in the same classroom environment.

2.6   Procedure

The study was conducted in two phases. In the first phase, both groups completed a pretest consisting of the multiple-choice test and the essay assignment. After the pretest, one group played the board game while the other group received the frontal lesson, after that they both completed a posttest consisting of the same multiple-choice test. In the second phase, both groups did the essay assignment in an hour of time. The essay assignment was conducted approximately one week after the first part of the experiment, and was rated by giving a grade between five and nine.

2.7   Data Analysis

The data collected from the pre-test and post-test were analyzed using descriptive statistics and t-tests to determine if there were significant differences between the experimental and control groups in terms of learning outcomes and interest in the 2030 Agenda. The argumentative themes were also analyzed using descriptive statistics and independent-samples t-tests to determine if there were significant differences in argumentation and counter-argumentation skills between the experimental and control groups.

3   Results

Based on the results it can be concluded that the use of a board game can be an effective tool for improving argumentation and counter-argumentation skills in middle school students. This conclusion stems from the observation that the treatment class obtained better grades than the control class with regard to the essay assignment (Mean Contr. 6.667 < Mean Treatm. 7.221). We observe that both classrooms showed high levels of interest and good learning outcomes, suggesting that even a slightly implemented frontal lesson, in this case seen with the use of slides in the control classroom, can have a positive impact. Regarding the t-test analysis we note that there are no particularly significant differences between the two groups, but this can be traced back to the small number of the sample, 19 students in one class and 21 in the other. Since the distributions are not normal (see Shapiro-Wilk test) I also did the Whitney-Mann test.

Overall, these findings suggest that incorporating gamification and argumentative writing tasks into classroom activities can be an effective approach to enhance soft skills of middle school students (Figs. 1, 2 and 3).
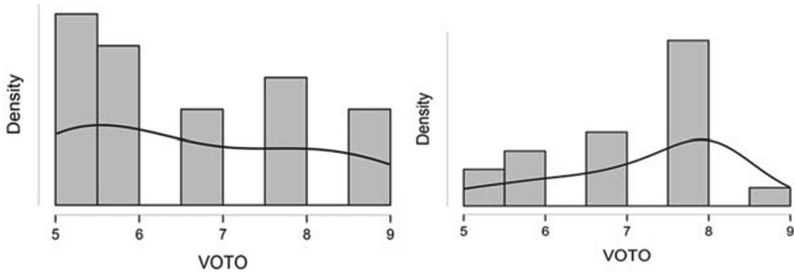

Fig. 1. Distribution of votes to the argumentative text. On the left the control group, on the right that of the intervention group.

	EXPERTISE_1		TALK		ABOUT		LEARNING INTEREST		EXPERTISE_1.1		LIKE		INTEREST		VOTE	
	CONTROL	TREATMENT	CONTROL	TREATMENT	CONTROL	TREATMENT	CONTROL	TREATMENT	CONTROL	TREATMENT	CONTROL	TREATMENT	CONTROL	TREATMENT	CONTROL	TREATMENT
Valid	21	19	21	19	19	17	17	18	18	18	17	18	21	19
Missing	0	0	0	0	2	2	4	1	3	1	4	1	0	0
Mean	2.333	2.632	1.524	1.526	3.684	3.588	3.000	2.944	3.833	3.722	2.941	2.944	6.667	7.211
Median	2.000	3.000	1.000	1.000	4.000	4.000	3.000	3.000	4.000	4.000	3.000	3.000	6.000	8.000
Mode	3.000	3.000	1.000	1.000	4.000	4.000	3.000	3.000	4.000	4.000	3.000	3.000	5.000	8.000
Std. Deviation	0.730	0.684	0.928	0.772	0.820	0.712	0.791	0.639	0.924	1.127	1.088	0.802	1.461	1.134
Shapiro-Wilk	0.774	0.593	0.625	0.684	0.874	0.837	0.813	0.646	0.853	0.729	0.922	0.840	0.874	0.858
P-value of Shapiro-Wilk	< .001	< .001	< .001	< .001	0.017	0.007	0.003	< .001	0.009	< .001	0.160	0.006	0.012	0.009
Minimum	1.000	1.000	1.000	1.000	2.000	2.000	1.000	1.000	2.000	1.000	1.000	1.000	5.000	5.000
Maximum	3.000	3.000	4.000	3.000	5.000	5.000	4.000	4.000	5.000	5.000	5.000	4.000	9.000	9.000

Fig. 2. Descriptive Statistics

Independent Samples T-Test						
	Test	**Statistic**		**df**	**p**	**Effect Size**
SESSO	Student	-0.178		38	0.859	-0.056
	Mann-Whitney	194.500			0.871	-0.025
EXPERTISE_1	Student	-1.329		38	0.192	-0.421
	Mann-Whitney	151.000			0.136	-0.243
TALK	Student	-0.009		38	0.993	-0.003
	Mann-Whitney	189.500			0.756	-0.050
LEARNING	Student	0.373		34	0.712	0.124
	Mann-Whitney	170.000			0.783	0.053
EXPERTISE_1.1	Student	0.229		33	0.820	0.078
	Mann-Whitney	161.500			0.747	0.056

Fig. 3. Independent Samples T-Test

LIKE	Student	0.323	34	0.748	0.108
	Mann-Whitney	164.500		0.944	0.015
INTEREST	Student	-0.010	33	0.992	-0.003
	Mann-Whitney	153.500		1.000	0.003
VOTO	Student	-1.305	38	0.200	-0.413
	Mann-Whitney	154.000		0.210	-0.228
Q_1	Student	-0.092	37	0.927	-0.029
	Mann-Whitney	187.500		0.941	-0.013
Q_2	Student	-0.036	37	0.971	-0.012
	Mann-Whitney	189.500		1.000	-0.003
Q_3	Student	-1.504	37	0.141	-0.482

Fig. 3. (*continued*)

	Mann-Whitney	159.500			0.146		-0.161	
Q_4	Student	NaN	a					
	Mann-Whitney	NaN	a					
Q_1.1	Student	-0.644		34	0.524		-0.215	
	Mann-Whitney	151.000			0.659		-0.068	
Q_2.1	Student	0.000		36	1.000		0.000	
	Mann-Whitney	180.500			1.000		0.000	
Q_3.1	Student	-0.541		35	0.592		-0.178	
	Mann-Whitney	162.500			0.607		-0.050	
Q_4.1	Student	NaN	b					
	Mann-Whitney	NaN	b					

Note. **For the Student t-test, effect size is given by Cohen's d. For the Mann-Whitney test, effect size is given by the rank biserial correlation.**

[a] **The variance in Q_4 is equal to 0 after grouping on INF_CRON**

[b] **The variance in Q_4.1 is equal to 0 after grouping on INF_CRON**

Fig. 3. (*continued*)

4 Discussion

This article discusses the use of gamification as an approach to learning, specifically in the context of sustainable development education, highlights the importance of developing effective educational approaches to promote awareness and understanding of the Sustainable Development Goals (SDGs) and for incentivising and enhancing argumentation and counter-argumentation skills. Gamification could be a promising approach to engaging and motivating learners and developing important skills such as critical thinking, problem-solving, and collaboration.

The use of game design elements and principles in non-game contexts has been shown to be effective in enhancing learning outcomes, including motivation, engagement, and knowledge retention. Additionally, the focus on developing important skills such as critical thinking, problem-solving, and collaboration is essential for success both academically and professionally, making it crucial to incorporate these skills into education.

One of the key strengths of gamification is its ability to engage and motivate learners, which is essential for promoting knowledge retention and improving learning outcomes. By incorporating game design elements such as points, levels, and rewards, gamification can create a more interactive and enjoyable learning experience that encourages active participation and fosters a sense of achievement.

Another important benefit of gamification is the possibility to provide students with opportunities to engage in productive discourse with others, and can help to develop argumentation and counter-argumentation skills that are essential for success both academically and professionally.

However, it is also important to note that gamification is not a one-size-fits-all solution and its effectiveness may depend on a range of factors such as the context of the learning environment, the age and developmental level of the learners, and the design and implementation of the gamified elements. Therefore, it is essential to conduct rigorous research to evaluate the effectiveness of gamification in different educational contexts and to develop evidence-based guidelines for its use.

The results of this study suggest that the use of a gamified approach, specifically a board game designed to improve argumentation and counter-argumentation skills, may be an effective educational tool for teaching the 2030 Agenda to middle school students. It's important to note that this study has a small sample size and is not an absolute test of the effectiveness. Rather, it serves as a basis for future work that can build upon these findings and refine the approach. In particular, future research could investigate the use of the gamified approach across multiple schools and with larger sample sizes, to determine whether the positive effects observed in this study are replicable. Additionally, it would be valuable to explore how the board game approach could be further developed and improved, potentially incorporating additional game design elements or adjusting the rules to better suit the learning objectives and preferences of middle school students.

Overall, the use of gamification in sustainable development education shows promise as an innovative and engaging approach to improving learning outcomes, particularly with respect to motivation, engagement, and the development of important skills such as critical thinking and problem-solving, or argumentation and counter-argumentation skills like in this study. More research is needed to fully understand the potential of this

approach, and to develop and refine effective gamified educational tools that can support the achievement of the Sustainable Development Goals.

In conclusion, this study has the potential to contribute to the broader literature on gamification in education and to provide valuable insights into the effectiveness of gamification as an educational tool for sustainable development education. By developing innovative and effective educational approaches to promote awareness and understanding of the Sustainable Development Goals, we can help to create a more sustainable and just future for all.

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