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THE EDUCATIONAL SERIOUS GAME AS A TOOL FOR MEASURING CONCENTRATION AMONG STUDENTS PRACTICING TABLE TENNIS: THE CASE OF THE FLOW GAMES IN INFORMAL UNIVERSITY SETTINGS[i]

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Abstract:
The problem of concentration is an objective issue, especially at the beginning of the 21st century, given the evolution of lifestyles and the digital revolution, so an unusual flow of information bombards human beings. This impacts all aspects of life, especially student life. This study aimed to research the educational serious game as a tool to measure concentration in students practicing table tennis: the case of flow games in informal university settings. A total of 21 students from different state universities, aged between 19 and 26, participated in a table tennis session. The students were divided into groups of 4 players for each game session that lasted between 3 min and 5 min. A concentration assessment test called "Flow-Game" was administered before the intervention (t0), immediately after each session (t1). This test is in the form of an electronic labyrinth. The results showed an average relative learning gain of less than 40% for the majority of students. In addition, the results showed that female students achieved significantly higher results than male students. These results suggest that the practice of table tennis

[i] DAS PÄDAGOGISCHE SERIOUS GAME ALS WERKZEUG ZUR KONZENTRATIONSMESSUNG BEI TISCHTENNIS-ÜBENDEN SCHÜLERN: DER FALL DES FLOWS SPIELE IN INFORMELLEN UNIVERSITÄREN UMGEBUNGEN

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and the calculation of concentration through serious game "Flow-Game" in the university environment in a formal education setting can be an effective medium and long term.

Keywords: concentration, Flow-Game, serious game, table tennis

1. Introduction

Currently, the world has undergone a huge change caused by the digital revolution and the information revolution. In fact, we are constantly bombarded with information, whether old or new, useful or useless, sufficient or insufficient, etc. Faced with the volume of information that reaches us, illusion and confusion reign. All this can cause several problems, especially psychological ones, such as stress, anxiety, and concentration disorders that affect a large part of the population of all ages and manifest themselves in the systematic forgetting of information. As the saying goes, "*Too much information kills information*." Several solutions proposed by researchers are used to deal with this problem, such as putting your phone aside or going to a place where no one will disturb you: to the library, to the café, to a private room. Close your social media apps. Some research suggests training your brain using scientific evidence that helps the brain perform specific tasks to concentrate through certain games, for example, puzzles, sudokus, and chess.

Clark and Mayer (2008) distinguish between two types of educational serious games: games dedicated to learning or developing cognitive skills and simulations allowing the implementation of training from a virtual environment. These new tools are currently in full development, and their fields of application are diverse: advertising (advergames), physical or cognitive training (exergames), games aimed at informing (newsgames), games available on social networks (social games), management simulation games (business games), games with an educational purpose (Green, C., Bavelier, D., 2012). According to Sauvé *et al.* (2007), a serious game is an activity that simulates an artificial situation in which one or more players face opponents (conflict) or collaborate against external forces (cooperation). Their progress is governed by specific rules (procedures, controls, and closure conditions) that guide their actions toward a precise objective, such as victory (winner vs. loser), overcoming chance, defeating the computer or other players, or seeking revenge on an opponent. Various recent studies have also demonstrated the positive effects of games in terms of knowledge acquisition and memorization (Botella C. *et al.*, 2011), motivation and personal sense of effectiveness (Pham Q. *et al.*, 2016).

Educational Serious Game is a competitive activity aimed at achieving educational goals in order to encourage the acquisition of knowledge. Alvarez and Djaouti (2008) state that the Serious Game is generally used to transmit messages, provide training, or allow the exchange of goods. Several approaches have been adopted in the literature to establish a classification of serious games, such as the taxonomy of Alvarez and Djaouti (2008). Directly inspired by the work of Sawyer and Smith (2008), our

research aims to use the educational game as a tool to measure concentration in table tennis students: the case of flow games in informal university environments.

2. Material and methods

2.1 Participants

The total number of participants was 21 students from different state universities, aged between 19 and 26 years old, who participated in a table tennis session. The population is diverse and comes from 4 different institutions (see Table 1). The students were divided into groups of 4 players for each game session that lasted between 3 min and 5 min. One student is excluded from the experiment because he or she took the test only without completing the re-test.

Table 1: Academic affiliations of participants

Institution	Abbreviation	Diploma	Speciality	Number	Total	Sum
Faculty of Economics and Management of Sfax	FSEGS	License	Management	3	16	21
			Finance	2		
			Accounting	1		
			Business Information Systems	2		
			Economy	4		
		Master	Economy	4		
Higher Institute of Business Administration of Sfax	ISAAS	License	Economy	1	1	
Faculty of Sciences of Sfax	FSS	License	Computer science	1	1	
The Higher School of Commerce of Sfax	ESCS	License	Management	3	3	

Students who participate in the table tennis game voluntarily participate in a non-formal setting, i.e. outside of formal class.

Table 2: Characteristics of the participants

Participants (n)		21
Age (years)		22,57
Gender	M	13
	F	8
Total	21	

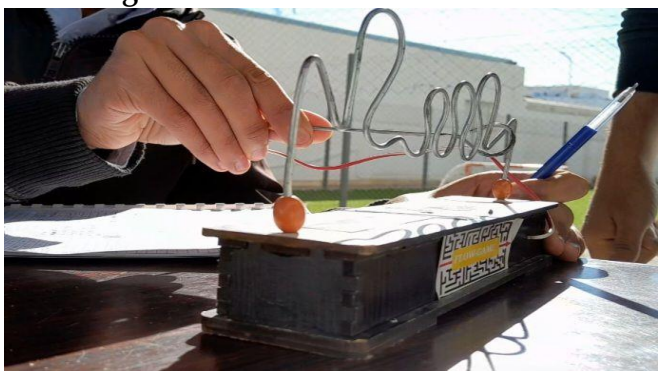
2.2. Procedure

An assessment test in the form of a concentration game is called a "Flow-Game". This game was administered before the intervention (T0) immediately after each session (T1). This test is in the form of an electronic maze formed of a wooden platform and a solid metal wire inclined wrinkled in a circular shape (Figure 1) and each student tries to make a passage and tries to make the minimum of mistakes. The sound effect suffered by the

game which shows the number of fouls for each passage. Before the survey of the sample was launched, a pre-test was done. Our first concern in the pre-test was to ensure the correct understanding of the game Flow-Game as much as possible.

Therefore, we applied this test to a small sample belonging to the survey universe, but it does not belong to the extracted sample and has broadly the same characteristics as the population studied. The "Flow-Game" test will take place in December 2024 at the Faculty of Economics and Management of Sfax of the University of Sfax during free time from classes. In addition, we explained the law of the game before the test.

Figure 1: Flow-Game Game Content



2.3 Flow-Game Protocol

- Each participant completes a single test before and after completion.
- The number of fouls for each attempt is calculated.
- If the number of fouls equals or exceeds 10 fouls, the trial ends immediately. That is to say, the maximum number of fouls equals 10.
- Each participant's score is the difference between the maximum number of fouls and the number of fouls.

Score = N.f max - N.f i i.e. Score = 10 - N.f

The foul number is between 0 and 10.

2.4 Concept Overview

The concept is based on two main components, each represented by a distinct logo:

- EduGame: the global concept represented by learning through play.
- Flow-Game: a specific serious game developed within the framework of this concept.

Both of these components can be found in Figure 2, where each logo is represented in a visual "visual identity" way.

Figure 2: The EduGame logo and the Flow-Game logo

Observation sheet: number of faults in Flow-Game before and after table tennis.

Table 3: Flow-Game observation sheet

	Institution	Age	Sex	Specialty	Before											After										
					Number of Faults										Score	Number of Faults										Score
1					1	2	3	4	5	6	7	8	9	10		1	2	3	4	5	6	7	8	9	10	
2					1	2	3	4	5	6	7	8	9	10		1	2	3	4	5	6	7	8	9	10	
3					1	2	3	4	5	6	7	8	9	10		1	2	3	4	5	6	7	8	9	10	

Legend:
Flow-Game Checklist
Each fault is represented by an **x,** and the rest is represented by a ✓.
Max number of fouls = 1
Number of Fouls: Number of fouls committed during the flow game (before and after the practice of table tennis).
Remarks:
This sheet allows you to compare errors before and after playing table tennis.
According to the French Table Tennis Federation. (2022), the game of table tennis is played in sets, usually with 11 points.

Figure 3: Table tennis (ping-pong)

2.3 Statistical Analysis

To process the responses, statistical analysis was carried out on a microcomputer using the "Excel" software. All statistics are considered significant when the probability threshold is less than $\alpha = 0.05$. Homogeneity, or coefficient of variation, is an index that measures the dispersion of data around the mean. It is calculated as a ratio and expressed as a percentage. This rate corresponds to the ratio between the standard deviation and the mean.

2.3.1 Homogeneity Formula

Homogeneity = Standard deviation / Mean

According to Hainaut (1975), the percentage of homogeneity indicates:

- Less than 15%: homogeneity is high.
- More than 30%: homogeneity is low.

Ouellet (1985) emphasizes that "*homogeneity is an indicator that gives an idea of the degree of agreement between the interviewees*." According to Gerrard (2003), a comparison of heterogeneity rates reveals that training reduced initial disparities among participants. This "equity" effect shows that apprenticeship has contributed to the harmonization of skills within the group. Thus, the differences in level have decreased, favouring a more balanced sharing of knowledge. This illustrates the role of training in promoting equal opportunities.

Also, according to Gerrard (2003), the effect of learning can be measured by calculating the "average relative gain" index. The analysis of this index for each objective makes it possible to accurately assess the pedagogical effectiveness of the training. Average relative gain refers to a measure used to assess the average improvement achieved compared to an initial situation. It is calculated by expressing the difference between performance before and after an intervention (such as training) as a percentage of the initial value. This metric allows for the comparison of progress between different individuals or groups, regardless of their starting levels. The average relative gain is calculated according to the following formula:

(Score AFTER - Score BEFORE) / (Score MAXIMUM - Score BEFORE) × 100.

An average relative gain of more than 40% indicates a positive effect of learning, reflecting a significant improvement in skills or performance compared to the initial situation. This threshold highlights the significant impact of the intervention on the development of the participants, reinforcing the effectiveness of the educational or training approach.

3. Result

3.1 Result 1: Effect of table tennis on students' concentration level from Flow-GAME in a non-formal education setting in the university environment.

Table 4: Effect of table tennis on the level of concentration of students from Flow-Game in a non-formal education setting in the university environment

Gender	**Before the game**	**After the game**
Period	6,05	7,38
Average	2,71	2,56
Ecar type	45%	35%
Homogeneity	0,59	0,56
Ereurtype	0,22	
GRB	21,72%	

First, according to the results mentioned above with regard to the table tennis effect on students' concentration level from Flow-Game in a non-formal education setting in the university environment, it can be seen that the rate of heterogeneity (coefficient of variation) decreased after the game h2 = 35% compared to the starting levels h1 = 45%, but this rate remains above 15%. This explains why the game did not reduce the gap that existed before the game, which explains why the learning did not have an "equity" effect. In other words, the differences in skill levels of the students participating in the research are not reduced subsequently, and the game does not participate in a greater "sharing" of skills. According to the results, it is still noticeable that there is a positive effect of learning (average relative gain) on concentration with a relative gain GRM = 21.72%. However, this rate remains insufficient for the acquisition of a skill (less than 40%). This indicates that students participating in the game do not feel that they have actually progressed during the game with regard to “the level of concentration”.

Result 2: Comparative study between males and females with regard to table tennis effect on students' concentration level based on Flow-Game.

Table 5: Comparative study between male and female with regard to table tennis effect on students' concentration level based on Flow-Game

Gender	**Male**		**Female**	
Period	**Before the game**	**After the game**	**Before the game**	**After the game**
Average	6,38	7,38	5,50	7,38
ecar type	3,12	2,81	1,93	2,26
Homogeneity	49%	38%	35%	31%
ereurtype	0,87	0,78	0,68	0,80
GRB	0,19		39,68	
GRM	18,61%		39,29%	

First, according to the results mentioned above with regard to the comparative effect between males and females on the level of concentration of students from Flow-Game.

For males, it can be seen that the rate of heterogeneity (coefficient of variation) decreased after the game h2= 38% compared to the starting levels h1 = 49%, but this rate remains above 15%. This explains why the game did not reduce the gap that existed before the game, which explains why the learning did not have an "equity" effect. In other

words, the differences in skill levels of the students participating in the research are not reduced; subsequently, the game has not participated in a greater "sharing" of skills. According to the results, it is still noticeable that there is a positive learning effect (average relative gain) on concentration with a relative gain GRM = 18.61%, but this rate remains insufficient for the acquisition of skill (less than 40%). This indicates that students participating in the game do not feel that they have actually progressed during the game with regard to "the level of concentration".

For females, it can be seen that the rate of heterogeneity (coefficient of variation) decreased after play H2 = 31% compared to the starting levels H1 = 35%, but this rate remains above 15%. This explains why the game did not reduce the gap that existed before the game, which explains why the learning did not have an "equity" effect. In other words, the differences in skill levels of the students participating in the research are not reduced subsequently, the game has not participated in a greater "sharing" of skills. According to the results, it is still noticeable that there is a positive effect of learning (average relative gain) on concentration with a relative gain GRM = 39.29%. However, this rate remains insufficient for skill acquisition (less than 40%). This indicates that students participating in the game do not feel that they have actually progressed during the game with regard to "the level of concentration".

4. Discussion

First, according to the results mentioned above with regard to the table tennis effect on the level of concentration of students from Flow-Game in a non-formal education setting in the university environment, there is a positive effect of insufficient learning (average relative gain) on concentration with a relative gain GRM = 21.72%.

This is consistent with studies by Johnson and Miller (2017), who show that table tennis does not have a significant effect on students' concentration because this activity promotes more immediate reflexes than sustained attention. In addition, according to White *et al.* (2020), "*improving concentration through physical activity requires an activity focused on an activity that requires a lot of awareness, which table tennis does not fully provide*."

However, there is other research that does not agree with our results, such as that of Smith and Jones (2018), which shows that table tennis significantly improves concentration in students through its speed, hand-eye coordination and cognitive responsiveness. In addition, White *et al.* (2019) show that fast-paced games such as table tennis promote brain flexibility by combining physical and mental activity to maintain a high degree of focus.

From the results mentioned above, it is noticeable that there is a difference between males and females vis-à-vis the table tennis effect on the concentration level of students from Flow-Game is in favor of female students with average relative gain GRM = 39.29% compared to male students with average relative gain with GRM = 18.61%.

Research on the effects of table tennis on concentration does not indicate significant differences between men and women. This is consistent with studies by

Johnson and Miller (2017), which show that table tennis does not significantly improve concentration in men compared to women, as part of research that deals with the effect of gender on cognitive performance.

However, this does not agree with studies by Johnson and Miller (2017), which show that the improvements in concentration observed in table tennis players are similar between the sexes. The studies of Brown (2019) and White *et al.* (2020) also show that cognitive performance in general, and concentration in a particular way, is influenced by individual factors such as experience and motivation and is not by the gender of the participants.

This study presents several contributions that are reflected on several levels: in terms of the originality of the research, the calculation of the effect of table tennis through the degree of concentration via a serious game is a very original concept, especially in a non-formal setting. In addition, it places great importance on student life, whether in scientific research or on a personal level. In addition, According to Renaud (2018), serious games play a crucial role in enhancing the learner's psychological and social well-being. While measuring the interest in our research, we can recognize some limitations: the research is limited to a limited number of participants, and the sample belongs mainly to a single faculty. In addition, each participant makes a single attempt, whereas repetition is an essential element in learning. For all these reasons, we conclude that our research opens up several perspectives: first, to expand the research to several faculties in different universities so that the project becomes a national project. Then, increase the population size and the number of repetitions for each participant to ensure deeper learning. Finally, to integrate games, whether serious or sporting, into the formal training programme, for their psychological and social benefits. It would also be relevant to integrate other types of activities, formal or non-formal, such as team building, whose common goal is team cohesion, an essential factor for learning and better mental health in student life and represents an excellent pedagogical tool to develop key cognitive skills.

5. Conclusion

Nowadays, leisure activities, often electronic and easily accessible via smartphones, exacerbate a growing issue: the lack of concentration. In light of this, seeking non-electronic alternatives emerges as an effective solution. Concrete games, particularly the Flow-Game, are powerful tools for disconnecting from screens. In a university setting, these games can be incorporated during informal moments, such as breaks or free time, in shared spaces like cafeterias. These opportunities not only foster connections among students within the same class but also encourage enriching interactions and idea exchanges with peers from other faculties. Founded in 2024, the University Sports Association (FSEG-Sport) offers an innovative solution to help students cope with the stress of studies and exams. This young association embodies a dynamic collaboration between physical education teachers, academic experts in education sciences, and

administrative staff. With an ambitious vision, it aims to achieve local, regional, national, African, Arab, and international recognition in the medium and long term.

Building on a family heritage rooted in education and sports, as well as an academic background combining sports sciences and education sciences, I present the concept of "Edugame". This project represents an innovative blend of education and games based on the gamification of education**.** This approach transforms learning into an enjoyable and engaging experience while adhering to the core principle of "fun to learn".

Conflict of Interests Statement

The authors declare no conflicts of interest.

About the Author

Ayman Guemri is a researcher in educational sciences at the Faculty of Economics and Management of Sfax (University of Sfax). Since 2021, he has also been the logistics manager of the university sports association FSEG-Sport. Coming from a family deeply rooted in education and sport, he has developed an academic background that combines sports science and educational sciences. With this dual expertise, he introduced the innovative concept of "Edugame" based on the gamification of learning. This approach aims to transform education into an enjoyable and engaging experience while adhering to the core principle of "the joy of learning." As part of this initiative, Ayman Guemri has designed several educational games, including: Deutsche Straße (2022) and Flow Game (2024). His research focuses on innovative learning methods, with a particular interest in serious games, team building, brainstorming and the development of soft skills. He specializes in the design and integration of educational and serious games in informal academic settings.
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