Technology adoption through games at Rio de Janeiro State: improving students' digital aptitude

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Abstract

Factors impacting technology adoption encompass technical, organizational, and human issues. This paper shows two projects that aim to develop students' digital aptitude by promoting a culture change from a game prejudiced environment into a habitat of technology-prone users. The first project, Ti-Games Maricá, took place three years ago, encompassing 50 schools in Maricá, in the State of Rio de Janeiro, and consisted of a school versus school game tournament, a series of workshops, talks, and other activities involving games. The research's main goal was to observe the impact of games in schools on increasing students' self-esteem and professional perspectives in technological fields. Another goal was to improve the use of technology in schools beyond administrative tools, attending to one of BNCC's recommendations. Based on the massive popularity of electronic games as a hobby for young Brazilians perceived in this previous project, the EducaTech-RJ project, on the other hand, consists of workshops that involve students on the theme "culture and digital literacy with a focus on computer games." The target audience is all the secondary schools of Rio de Janeiro State, engaging 1231 schools. The project aims to increase student's awareness of the possibilities of adopting, manipulating, and creating technology. The workshops are also an opportunity to collect data about technology adoption and envision technology as an educational tool in schools.

Keywords: Technology Adoption, Games, Digital Culture, Digital Literacy

1 Introduction

The use of technologies in school teaching and the appropriation of technologies by students are essential themes for the State education network in Rio de Janeiro. Preparing future generations for their adult lives, especially regarding their active participation as citizens and as economic agents in the productive system, should be a fundamental goal of formal education. This is one of the goals established by Brazil's Constitution and the guidance provided by Brazilian national curricular standards, known as Base Nacional Comum Curricular (BNCC). BNCC also strongly recommends using technology in schools beyond administrative use and incorporating Information Technology in everyday school life. This recommendation is based on today's society's relationship with technology and current industry demands.

This article extends a previous paper (Prado et al., 2021a) that presents the Ti-Games project. In this extended version, we present a follow-up project with broader yet associated goals, conceived after Ti-Games to intensify the use of technology as a tool to elevate students' quality of life and facilitate the adoption of technologies to improve teaching in public schools in the State of Rio de Janeiro, Brazil - The EducaTech-RJ project. Based on the research developed in the city of Maricá focusing on the Ti-Games tournament (Prado et al., 2021b), computer games are used as a motivator for technology adoption in classrooms, and as a way to provoke students about their ability to come up with creative solutions to their problems. The Ti-Games project had positive results, and the research showed increased student confidence and a possible increase in sociability. The students were taken from a game prejudiced environment into a habitat of technology-prone users, promoting a digital aptitude.

With the lessons learned with Ti-Games, a new project was proposed – EducaTech-RJ. Besides reporting different results from Ti-Games, in this article, we also report the planning, execution, and preliminary results of EducaTech-RJ, whose main actions are workshops for students on the theme "culture and digital literacy with a focus on computer games." In addition to working on increasing students' awareness of the possibilities of adopting, manipulating, and creating technology, the workshops are also an opportunity to collect data and increase the adoption of technology as an educational tool in schools. Processing the collected data for further analysis is another goal of the EducaTech-RJ project. The choice of the workshop's theme, which relates digital literacy with games, was firmly based on the previous experience within the Ti-Games tournament initiative. The involvement of the school community and the local

community with Ti-Games evidenced the feasibility of a change in the perception of the use of recreational digital technologies in the school environment (Prado et al., 2021a). The teachers directly involved with the tournament were positively surprised by the engagement of their students and the mobilization of the community (Prado et al., 2022) in the project, which led them to consider the adoption of technology not only as something that could bring significant impacts to their practice but also as a step not so far from being achieved with the resources that the school already had. These lessons learned lead us to bet again on games as a gateway to improving the use of technology in schools in Rio de Janeiro.

1.1 Terms and definitions

To avoid the debate on what constitutes a game and the many common mishaps due to translation, the term "game" used in this research refers to electronic or digital games of entertainment – excluding those created for gambling. While the term "gamer" used in this research refers to people who play electronic or digital games of entertainment, using the exact definition as the English dictionary Merriam – Webster (2022). It is important to note that in Brazil, the word 'game' is already associated with digital or electronic games of entertainment, and the word 'gamer' is a way to refer to game enthusiasts.

The term' digital culture has become mainstream with slight differences in its definition. Nevertheless, at its core, it refers to human interaction shaped by digital interfaces. Digital culture can sometimes be mistaken for digital literacy, a term used less frequently. For this research, digital literacy is the capacity for critical thinking in digital environments, a parameter for evaluating the capability of using and understanding digital technology.

Technology and its definition have long been the goal of academic discussions. However, for this research, we shall use its usual meaning as established in standard dictionaries of Brazil – as tools, methods, and techniques developed for solving problems or specific purposes, according to Michaelis (2022).

In this paper, we use the term Digital Aptitude to describe the confidence and ability of one's self in learning and using digital technology. Projects like Ti-Games and EducaTech-RJ promote a culture change from a game prejudiced environment into a habitat of technology-prone users by stimulating students' social, emotional, and technical skills.

2   Technology adoption in schools

The Technology Acceptance Model (TAM) (Davis, 1989) was developed based on the psychology model for Theory of Reasoned Action (Ajzen et al. 1975). The main goal of the model is to understand why people decide to accept and use certain technologies. The TAM (Figure 01) was later studied and further developed into other more specific models; however, the basis for understanding why people choose which technology to use remained the same. How people perceive technology is the foremost reason whether someone decides to engage or not with a kind of technology.
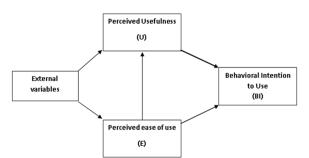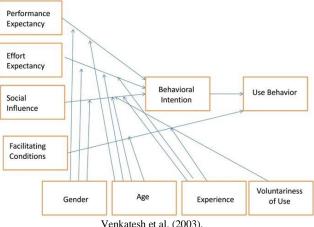
Figure 1 - Technology Acceptance Model. Adapted from Davis (1989)

According to Davis (1989), two primary constructs determine the use of technology. One is that of "Perceived Usefulness" (PU), which focuses on the degree to which an individual believes that utilizing one particular system would better his performance at work, and "Perceived ease of use" (PEOU), which looks at the degree in which an individual believes that utilizing a particular system will be free of physical or mental effort.

Many behavioral elements were included to explain technology adoption, such as subjective norms, the relevance of the task, and the demonstrability of results (Venkatesh et al., 2000). They are present in later models such as the Unified Theory of Adoption and Use of Technology – UTAUT (Venkatesh et al., 2003). The perception of effort regarding the use of technology was the second strongest motivator behind the intention to use it (Figure 02). Furthermore, this "ease of use" notion also influenced the primary motivator of all, the performance expectancy. According to her research, the user is generally predisposed to engaging and learning such technology when the learning curve is perceived as smooth.

Figure 2 - Unified Theory of Adoption and Use of Technology Source:

Venkatesh et al. (2003).

Her research also showed another extremely relevant factor determining when a new technology is embraced and used: social influence, how people are influenced by those who are socially important to them approving or disapproving of the use of technology. For this reason, it is easy to see why social influence, might be a significant factor in technology adoption in schools, especially those with high rates of digital illiteracy.

Considering how new technologies are accepted and excluding monetary factors, analyzing only the human aspect of adoption from the teacher's perspective, it is possible to visualize scenarios that explain why Brazilian public schools are delayed in technology use.

Teachers that try to implement new technologies might feel pressured and outcasted by those who do not wish to learn and use new tools. This may be further induced by the fact that public school teachers, like most public servants in Brazil, cannot be dismissed unless through a complete administrative process, with extremely specific infringements, all of which the person can contest (Brasil, 1990).

It may create tiny resistance bubbles in schools, where teachers resist change. Other resistance scenarios might develop due to personal lack of access to information and tools to experiment, which would increase the "ease of use" perception. The fear of change might be linked to several scenarios, but most might stem from lack of access, lack of incentive to experiment, and lack of familiarity. In this regard, games might be the best option for mass technology adoption in schools due to the issues discussed as follows.

3 Relevance of digital culture and digital literacy for education

While literacy is the ability to read and understand texts, digital literacy, according to Cappelli (2021), is the skill needed to work in virtual environments. In this new technological era, it is an essential ability.

Digital tools are increasingly dominant both in the job market and in leisure activities, and especially in the way, speed, variety, and amount of data that are operationalized by these tools that demonstrate direct interference in our way of thinking, acting and feeling. There was an increase and acceleration in the need for remote work – home office – automation of services, online shopping, more extensive databases, and the pandemic in the market to find leisure without leaving home through cell phones, televisions, and computers.

In addition, social media platforms have become increasingly profitable spaces, enabling worthwhile activities, contributing financially directly, such as YouTube, which monetizes (compensates) the videos, or indirectly, such as influencers who earn from advertisements of other products at the same time. Marketing to their followers or even functioning as spaces for expanding the influence of some non-digital product.

With the increased technology use, people have gradually started to immerse themselves in a digital world. One must know how software and hardware work for the most straightforward actions. This knowledge is part of this digital literacy, the individual's ability to use technological tools effectively. This effect occurs with the daily and intended use of the tools, understanding how to solve problems, communicate with others, and, in general, make the most of it to make daily life easier.

According to Mckinsey (Hanafizadeh et al. 2011), in this post-pandemic scenario of digital acceleration, it is estimated that by 2025, 52% of operational activities will be carried out by machines or software. It is also notable the increase, on the part of multimedia, in the offer of increasingly immersive experiences that provide the involuntary immersion of users in their networks through the use and stimulation of their senses (sight, hearing, touch, taste, and even attempts to sharpen smell).

A new intrinsic competence is required for the new hyperconnected society. Digital literacy is no longer an optional skill and has become an individual and group need, now living in a network. Because of this need, we highlight the relevance of the development of digital literacy aimed at the formation of the global citizen that instigates more than just private matters but also leads to thinking about a work that must be developed together. Digital literacy prepares the individual to exercise citizenship on a more conscious level as it amplifies their understanding to deal with the idiosyncrasies of the digital environment.

To illustrate our claim, let us consider a very recent fact. Although we know students are familiar with the use of digital technologies, during the period of the pandemic in which students and teachers were migrated to digital environments, we had many reports of students who were unable to access platforms due to social inequalities, as pointed out in the work of Catanante et al. (2020) or for operational reasons many "digital natives" were unable to perform some tasks shared by their teachers.

The school must walk with technological advances and implementations to cope with this revolutionary reality of industry 4.0 so that individuals are trained for active participation in the implementation, measurement of results, and expansion of perspectives in the face of new tools avoiding technological somnambulism.

Moura et al. (2021) presented an experiment focusing on technology adoption for creating stories in digital comics in school. After the students' collaborative work, the author improved 75% in class performance. Moura et al. (2021) highlight the difficulty that many schools face in implementing new technologies as tools to support and stimulate learning both outside and within traditional education environments.

Martin et al. (1996) state that a large part of this problem is strictly related to the student's difficulty in putting into practice the routines, planning, and control of cognitive processes that involve the performance of tasks.

Bringing change into an established scenario is not easy. It is difficult employing isolated actions to overcome the main problems preventing the implementation of new effective technologies in the school context. That is why projects such as Ti-Games and EducaTech-RJ believe in the use of innovative approaches for the improvement and effective implementation of technologies in schools.

4 Brazil's technology dissonance

In 2011, two renowned professionals of the digital audiovisual industry – Ian Livingstone and Alex Hope –

made a study for England's Ministry of Culture. This report stated that reforms focusing on technology use in basic education are paramount for developing high-tech industries. The study showed that most students ended up not receiving information nor having access to technology that enabled the development of skills required for digital industries. This lack of access during school years amounted to students not even envisioning professional possibilities in these areas, let alone preparing them for the high-tech industry, such as game development and visual effects.

There were more than 75.7 million players in Brazil, according to research company Newzoo (2018). In that same year, Statista (2021), a leading technology consumption research company, showed that Brazil was amongst the top five countries that most consumed the internet, with most of the population accessing the internet at least once a day. In 2020 it was also reported by Statista (2021) that Brazil surpassed the United States in individual time spent on social media per day. In defiance of these facts, most public schools in Brazil offer no infrastructure even to the most basic levels, such as basic computers or internet access, let alone programs focusing on technology use or receptivity.

One evidence of how Brazil's public schools' environment is perceived by current students (digital natives) is in the last Program for International Student Assessment (PISA, 2018). While this evaluation has been done every two years for the last twenty years, there has been little sign of evolution regarding the public school environment as perceived by students. "Bullying, indiscipline, and loneliness: the climate of Brazil's schools as revealed by PISA in 2018" was the headline that gave way to international notoriety of a system with little to no focus on embracing students.

The same report states that Brazil had a 50% dropout rate, and 41% of the students recognize the high levels of indiscipline. 23% felt alone in school, while 13% self-declared feeling sad in school. These rates were, in some cases, twice the rate found in most OECD countries. The report points out that a better school environment helps reduce the dropout rate; in 2012, Brazil had the third highest rate amongst countries researched by United Nations Development Program (UNDP).

5 Games as a catalyst for technology adoption in education

Marc Prensky is one of the leading voices behind the reasoning for a technological focus in schools. Prensky (2006) argues for the use of games in the development of children and adolescents. In his opinion, teachers are "digital immigrants" while the current younger generation (students) are "digital immigrants." This disparity leads to communication problems. Author of the terms "digital native" and "digital immigrant," he believes "digital natives" are those who were born in a world filled with digital interfaces, contrary to "digital immigrants," who saw these technological developments.

In this perspective, Zhonggen et al. (2019) in which they carried out an analysis of a decade on the Web Base,

Sciences found as positive aspects of the use of serious games in education, such as the gain of cognitive skills, the possibility of greater flexibility in learning, and the performance gain. For this research, her observations on how games increase players' optimism and self-confidence are fundamental for comprehending the results obtained. However, her views on games as social tools are shared by philosopher Huizinga (2005), "playing and games can promote social grouping."

It is visible why students thoroughly accept games: not only most of them are gamers, which favors the social influence factor, but games are seen not as tools but as entertainment and, for this reason, the "ease of use" factor brings a higher impact on intention to use (Silva, 2006).

As mentioned, many times by game designer Koster et al. (2013), learning is one of the main elements of play. It is what players do most of the time since ultimate mastery of the game generally means it is time to play a different one. However, contrary to expected, games may also present a higher adoption rate amongst school staff if given a chance.

Technology is ever-changing, mirroring cultural expansion (Pfaffenberger, et al. 1988). For this reason, mastery is not and should not be required for its use in schools by teachers. This prerequisite would create an everlasting state of inadequacy for teachers. Technology, therefore, must be embraced as a culture and language within schools, bringing students and teachers together. This first step of establishing common ground on digital culture could pave the way for a culture of technological embrace, furthering technology experimentation in schools and improving communication between teachers and students, as suggested by Prensky (2001).

According to Ertmer et al. (2010), school culture is a crucial variable in technology adoption for teachers. How the school as an institution and the school direction perceives technology use plays an essential role in influencing teachers. This is one of the reasons why the project which shall be analyzed here, Ti-Games, required school direction presence during game activities within the school.

Games offer a viable solution to mass technology implementation in schools in Brazil due to their statistical ubiquitous hobby status combined with their accessible nature, not only concerning their ease of use but also regarding their availability, as shown in the Latin America Digital Transformation Report (Atlantico, 2020) about the high rate of internet and mobile internet penetration in Brazil. Games could provide a cultural basis for the institution that would permeate teachers and students alike, fostering a change towards further technology implementations in schools.

Games have been used before as a gateway interest for many areas of study, such as robotics, programming, 3d modeling, and other related fields (Brum, 2017). While not the focus of this paper, game-based learning is, in fact, a technique that involves the use of commercial entertainment games as a gateway or interest stimuli for specific content and subjects (Boller, 2003). There are several ways to use this technique. However, most consist in using the student's interest in games or a specific game to bridge another related subject.

This approach requires knowing the game and the subject beforehand to plan this association appropriately.

Rio de Janeiro's State Education knew about using games as a gateway interest for other related areas of study before the project mentioned here. It is worth noting that the school that won Ti-Games Maricá was a school administered by Rio de Janeiro's State, Stadual School of Elisiario Matta (Prado et al., 2022). This was one reason the authors were invited for the Rio's State Education project mentioned earlier. For these reasons, using games as a path for promoting technology adoption in schools was not an issue that required much explanation.

6   Ti-Games Maricá project

Ti-Games Maricá was a project executed over the school year of 2019 in the city of Maricá, State of Rio de Janeiro (Prado et al., 2021b). While the main activity was a school versus school game tournament, there were a series of workshops, talks, and other activities involving games. This project was the city's first initiative toward building a game development cluster.

The research's main goal was to observe the impact of the use of games in schools in a legitimate manner. More specifically, we hoped to observe if the use of games in the school environment, by the school itself, would increase student's self-esteem and professional perspectives in technological fields and if the legitimate use of games could have other positive influences. Another goal is to improve technology in schools beyond administrative tools.

Ti-Games was a citywide educational project involving 50 schools, 2.500 students, and 400 teachers. The core of the Ti-Games project was a yearlong school versus school game tournament.

One of the goals of the project, Ti-Games, concerning students, was to help students develop socially through games and their self-esteem via legitimate game activities held within the school environment and by the school itself. For this reason, the project, including the video game tournament, was developed focusing on cooperation, and the formation of school spirit and had no monetary gains and no ranking of individual students.

6.1 Ti-Games tournament setup

This experiment was developed within a project with three steps as shown in Figure 3, where the first step was an experiment carried out with 150 public teachers from the local Administrative Entity of Education.
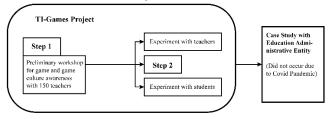

Figure 3 - Ti-Games research design

During step 1, all teachers participated in a game-based technique workshop, with sixteen-hour duration, in four four-hour classes and with the participation of groups of up to 35 teachers. The goal was to present and introduce game-based teaching techniques to the city's public education network, since most schools in Maricá are public. This part of the project is not the focus of the current article.

The second step was the main part of the project and involved multiple game-based activities in all fifty schools of the city of Maricá, during a complete school year. More than 2,500 students and 150 teachers and school principals participated in Ti-Games voluntarily.

The third and final step was a case study with the Public Administrative Entity of Education of Maricá to see their vision of the project and better understand the extent of the positive impacts attributed to the contest. This stage was shortened due to the Covid.20.

During the second step (figure 3), each school received internal game activities such as workshops, talks, and video game tournaments in its first phase. This was done to select students with a greater affinity with games. The only prerequisites were being a gamer between the age of 12 and 18.

All schools had at least one principal or director participating in a brief talk about games and their educational uses. Teachers of these institutions were also invited to the talk. They were briefed on the game industry and its economic relevance. We intended to stamp out misconceptions about games and bring this generation of "digital immigrants" closer to their students, who are "digital natives."

Students were then assembled to discuss career possibilities in the game industry to broaden their vocational perspectives. The first practical activity with the students was a game design workshop to show how games are made. The second main activity for these students was a video game competition to form the school's team.

After forming a school's team, the institution advanced to the tournament's second phase, the school versus school tournament. The first phase ended at the same time for all fifty schools.

This project's second phase required institutions to compete against each other similarly as students did within each school. However, the point system used was solely meant to register the effort of each school in being present at these external activities. It was not disclosed to students so as not to deter them from trying hard.
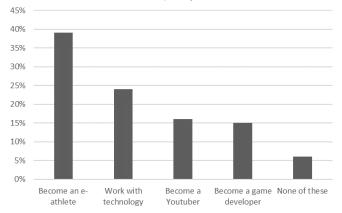
Since the project was about effort and school mobilization through games, semifinals and finals happened in one event. The prize, a "gaming room," and a metal plaque with the team's names, was awarded to the first and second-placed teams. There were no individual rewards to prevent students from focusing on monetary gains.

7   Student experiment and results

Data collection was carried out at the end of the Ti-Games only with students who reached the semifinals. Therefore, only some of those present at the end of the project, answered

the questionnaire, with results showed in Table 1. While 2,500 students did participate in Ti-Games, there were only around 200 students in the semifinals and finals, and since participation was voluntary, as well as responding the questionnaire, only 88 answers were collected.

While 2500 students did participate in the first phase of

Figure 4 - Interest in acting in the technology. Source (Prado et. al, 2022)

activities, the second phase was held with more ongoing events, and most of them were in after-school periods. This generated interesting and unexpected results, such as the mobilization of school communities. Parents, friends, and teachers helped teams reach events. Since the intention was to measure the impacts of the whole experience and to try to comprehend the effects of legitimate game use in schools after a whole year, only students present in the semifinals and finals could answer the research

As a result, 71% of students cited teachers' incentives to participate in the contest. In addition, most students – precisely 81% – do not believe they would receive this incentive from the school, encouraging them to participate in contests in this model.

These students were asked about their abilities and potential to win game competitions. 59% answered that they already imagined participating in competitions of this kind. However, 96% of the students said they felt confident in winning future contests. We believe this is a fundamental factor in demonstrating that these students' belief enhances their abilities.

After analyzing the data, we noticed that 39% of the students admitted that they feel motivated by the possibility of becoming professional players (e-athletes). What caught our attention was the lack of correlation between this and the fact that 76% of students claim to have thought about becoming game developers before Ti-Games.

Nevertheless, it is essential to highlight that all students who were present and actively participated in the activities were gamers interested in gaming culture.

Furthermore, we found that 24% explicitly expressed their willingness to work with technology, 16% showed interest in becoming Youtubers, and 15% expressed interest in becoming game developers, as shown in Figure 4.

Participants were asked if they had already suffered, in any way, any prejudice for liking games, with 57% saying no.

Initially, this result may seem contrary to what we expected – a high level of prejudice – but all students who answered this questionnaire managed to reach the end of the project, which leads us to consider that they probably received more significant support from their parents and community. In this way, we do not rule out the possibility that a greater number of students, particularly those who do not have good financial resources, have already suffered some kind of prejudice for liking games, as shown in Table 1.

Our last question was Regarding the students' opinion about the project: "what did they like the most about the project?" Even though five possible answers were available, 61% of the students said they liked knowing that the city of Maricá is a city of openness for players and reinforced the importance of the game through official government institutions.

The second aspect highlighted by the students, with 18% of the responses, was making new friends. We believe that this may be the most relevant sign of the potential of games as social tools, or at the very least, it indicates a repressed potential of the emergence of a need to create a gaming community in Maricá before the Ti-Games contest

Table 1- Descriptive analysis of data collected with students who reached Ti-Games. Source (Prado et. al. 2022)

Interest in a free game developer course	
Yes	74%
Maybe	25%
No	1%
Got encouraged by any teacher	
Yes	71%
No	29%
Ever imagined being in a game contest	
Yes	59%
No	41%
Ever thought school would encourage a game contest	
Yes	19%
No	81%
Believe could win other contests	
Yes	96%
No	4%
Ever faced prejudice for playing games	
Yes	43%
No	57%
Ever considered becoming a game developer	
Yes	76%
No	24%
What enjoyed the most	
Know Maricá is focusing on game development	61%
Make new friends	18%
Learn how games are made	8%
Know there are professions connected to games	6%
Have more time to play games	5%
Other reasons	2%

Although Ti-Games is considered a tough competition, 2,500 students actively participated and competed in various ways over an entire year. Participating in this challenge encouraged students who felt more confident about the possibility of winning new game competitions. Through data analysis, we can also conclude that most students who participated aspire to work with games or gaming-related professions. With that, we can conclude that Ti-Games has achieved one of its primary goals to a high degree. We can also legitimize other positive results by integrating games in schools. However, it is necessary to develop further research to measure how the Ti-Games project influenced these results.

7.1 Analyses of results of the Ti-Games project

By crossing the analyzed data with the works of references and authors mentioned in the theoretical referential chapter, we obtained a strong correlation between the Ti-Games result and some of the claims.

Next Gen Report (Hope et al., 2011) has as one of its main assertions that the use of technologies as merely administrative use in schools prunes the professional perspectives of students in areas related to high technology.

As a result of the experience, we concluded that most students, who worked until the end of the project, wanted to work with games. We have previously stated that 76% of students consider becoming game developers, which means a possible impact on the use of games in schools and by schools.

One of the research's main objectives was to understand whether games are a good option for implementing technology beyond administrative use in schools. The results we obtained further reinforce the statement made by Hope et al. (2011) in their report while also answering one of the questions, "does the games used legitimately in school activities increase the interest of students in professions based on digital?".

We highlight the increase in student confidence due to participating in a long and challenging game contest. As we can see, although many lost the contest, there was no apparent dismay on the part of these students who, on the contrary, will demonstrate self-esteem to win future game contests. Jane McGonigal (2015) also states that playing games can improve optimism.

Pedersen et al. (2004) developed similar research on sports performance and self-esteem that had their improvement proven in adolescent girls after participating in sports achievement experiences. Unlike the work mentioned above, Ti-Games is not a physical sports competition. However, it can be considered an electronic sports competition, which seems to answer the question about the use of games in school, increasing the self-esteem and confidence of the students. As shown by Miller et al. (2010), Hamidi et al. (2019), and other studies investigating the impacts of game use and game-based learning at school further confirm this possible increase in self-esteem due to the legitimacy of the game in schools.

The union of students during the development of the experience is evident, which we consider the second-best result of the competition.

The mobilization of the school community – although we do not have data to demonstrate – was also evident during the development of the contest, especially in the school versus school phase, it took place outside school hours, and many teams depended on parents for transport. The occurrence of several teachers who volunteered to take students beyond school hours and sometimes on weekends also reinforces our previous conclusion. This correlates even more with what Jane McGonigal (2015) says about games that help build and strengthen social connectivity. Corroborated by one of the most cited authors on games, the philosopher Johan Huizinga (2005).

The fact that these students are digital natives may have contributed to the results presented above. According to Prensky (2001), digital natives have increased their receptivity to technology because they can quickly understand new technologies.

What surprised us the most, considering the contest format where the games were not advertised, and most titles were unknown to the students who participated, was the quick learning of the participants just watching the games.

Sharing among students, those who did best sharing information about how to play, even though they were competitors, demonstrates that cooperation among participants was high. As Jane McGonigal (2015) puts it, players want to cooperate, showing what they know. This sporting attitude matches these digital native participants.

The high interest of students is evident in the development of the contest, even though the number of responses obtained 88 is very low compared to the number of participants – 2,500. The number of participants allowed by the Maricá city hall was limited to only 2,500 (maximum number of signatures allowed) because she believed a more significant number could disrupt daily school life.

Despite this limitation, some schools even have four hundred enrolments. Furthermore, the interest demonstrates digital natives' affinity with games and their culture.

With the lessons learned with Ti-Games, a new project was proposed, EducaTech-RJ, whose main actions are workshops for students on the theme "culture and digital literacy with a focus on computer games." EducaTech-RJ is now a project being implemented by SEEDUC-RJ in 2022. The conception and implementation of EducaTech-RJ can be considered the most concrete consequence of the Ti-Games project.

8 EducaTech-RJ Rio de Janeiro state education's program for technological education

Technological advancements in the industry require newly qualified professionals within society. The entire educational ecosystem must have all the technological advances to guide students in this emerging market. The EducaTech-RJ (Brasil, 2022) project aims to implement

scientific and practical technology innovation in the public educational system of Rio de Janeiro state. EducaTech-RJ (Brasil, 2022) was proposed after Ti-Games lessons. The main actions from EducaTech-RJ are workshops for students on the theme "culture and digital literacy with a focus on computer games." In addition to working on increasing student's awareness of the possibilities of adopting, manipulating, and creating technology, the workshops are also an opportunity to collect data and increase the adoption of technology as an educational tool in schools. The collected data is then analyzed to better understand how students perceive technology and its adoption in their schools.

The choice of the workshop theme, which relates digital literacy with games, was firmly based on the previous experience within the Ti-Games tournament initiative. EducaTech-RJ (Brasil, 2022) was developed to identify, evaluate, endorse, and recommend the use of new and contemporary tools and pedagogical practices, having as its primary objective the modernization of public High Schools in the State of Rio de Janeiro. This work is done through 3 axes: Research, Production, and Dissemination. Based on research, specific actions are developed considering the involvement and participation of the entire network of schools in the State of Rio. Despite the necessity of education being on par with the current digital era, this emerging digital culture also requires ethical awareness for its best practices and uses. Research is the base for all actions and proposals developed by EducaTech-RJ (Brasil, 2022).

The project aims to fit the actions of the State of Rio de Janeiro to the national curriculum guidelines for education and the National Common Curricular Base, explicitly concerning the development of technological education, as well as the indispensable Skills in Mathematics and Reading Comprehension, which are vital knowledge pillars in the 21st. Century.

8.1 EducaTech-RJ workshops

The workshops proposed aim to draw attention to the technological foundations so that, in this way, the use of technology can be intensified as a tool to improve/develop students' quality of life and facilitate the adoption of technologies in schools. In addition, students' qualification in digital technology increases their chances of entering the job market.

The themes for the workshops were selected based on some aspects:

I.   Capturing students' interest and leaving a positive impression motivated the choice of a playful theme related to entertainment
II. Introducing concepts related to challenges, ideas, and technologies
III. Arousing interest and increasing students' perception of the potential and possibilities of technology and innovation for their empowerment in today's society.

Each workshop lasts 4 hours and is offered to up to 40 students. A minimum of 15 workshops are being conducted

these two months. Each workshop has two objectives: on the one hand, to provoke an increase in students' digital aptitude; on the other, to collect data about technology adoption in schools.

At the end of each workshop, anonymous data (without identifying students) is collected and analyzed to perceive differences in students' technological conceptualization and adoption and to gather ideas to improve the efficiency of the following workshops. The data collected during the workshops will be consolidated into a database for analysis and future research. It is expected that the data collected will enable comparisons by region and by type of school.

The first workshops were conducted in different schools. Their principals were unanimous in reporting their approval and concordance with the chosen theme, i.e., "culture and digital literacy with a focus on computer games." The workshop's conductors are game designers. A bond between students and game designers is created when the games are presented. The students engage in the workshop and want to learn more about someone who lives as a professional of the game industry.

As one of the principals stated:

> "[...] (the students) were involved, and you managed to do that [...] I am delighted. [...] There was even a moment when you said you were going to end the workshop it and they "aaaaah… (sad sigh)", and then we see how much they like it."

9   Conclusion

The Ti-Games project had many positive results according to its goals, such as the relevant social impact of a citywide mobilization towards a common goal (Ti-Games). While these are not the same goals as the research done with its data, both seem to indicate the benefits of utilizing games and game-based activities in schools.

Prado et al. (2021b) showed an increase in student confidence in their professional perspective in the game industry and a possible increase in their sociability. The research also revealed that a change in school culture is possible and that game-based workshops designed for teachers may help change their perception of game use in schools. The positive mobilization of the school community via game-based activities held or incentivized by the school was another result indicated by the research (Prado et al., 2022).

However, the most important research contribution was the comprehension of numerous future possibilities on the impact of games in education. For example, there were some students with autism that actively took part in the activities. This meant that a few teams had at least one representative with autism. Understanding the project's total impact on students with disabilities would be an interesting line of research.

Even though we could not observe the project's lasting impacts on students due to the Covid-19 Pandemic in 2020,

Ti-Games' findings opened the way for the proposal and implementation of EducaTech-RJ (Brasil 2022).

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