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Educational and Technological Tools in the Prevention of Parasitic Infections in Youth and Adult Education

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ABSTRACT

The Education of Youth and Adults (EJA) seeks the inclusion of individuals who have dropped out of school by providing them with educational opportunities. In this process, the introduction of didactic tools and playful activities is essential, as it awakens interest and understanding for learning. The integration of digital technologies in education is seen as a way to transform the learning process, providing more interactive and effective methods, with an emphasis on digital games as pedagogical tools that offer meaningful learning experiences. A study with EJA students at a municipal school in Maceió, Alagoas, conducted between July and August 2023, explored educational methods in teaching intestinal parasitic infections. Activities, including the construction of models and didactic games, not only sparked students' interest but also promoted awareness of preventive measures, such as hygiene, which was highlighted by 33% of the students. In the quiz applied, the correct answers ranged between 36.5% and 59.6% of participants, and 67% of students participated in the educational game, showing interest in these playful activities. The research highlighted the importance of innovative and practical educational approaches, emphasizing the role of the teacher and the school as transformative agents, as well as stimulating learning.

RESUMO

A Educação de Jovens e Adultos (EJA) busca a inclusão de indivíduos que aderiram à evasão escolar proporcionando-lhes oportunidades educacionais. Nesse processo, a introdução de ferramentas didáticas e atividades lúdicas é essencial, pois desperta o interesse e a compreensão para o aprendizado. A integração de tecnologias digitais na educação é vista como uma maneira de transformar o processo de aprendizagem, proporcionando métodos mais interativos e eficazes, com destaque para os jogos digitais como ferramentas pedagógicas que oferecem experiências de aprendizado significativas. Um estudo com estudantes da EJA em uma escola municipal em Maceió, Alagoas, entre julho e agosto de 2023, explorou métodos educacionais no ensino de parasitoses intestinais. As atividades, incluindo a construção de maquetes e jogos didáticos, não apenas despertaram o interesse dos estudantes, mas também promoveram a conscientização sobre medidas preventivas, como a higiene, destacada por 33% dos estudantes. No quiz aplicado, as respostas corretas variaram entre 36,5 e 59,6% dos participantes, e 67% dos alunos participaram do jogo educativo, demonstrando interesse nessas atividades lúdicas. A pesquisa destacou a importância de abordagens educacionais inovadoras e práticas, ressaltando o papel do professor e da escola como agentes transformadores, como também, estimulando o aprendizado e desenvolvendo habilidades.

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Introduction

Due to being a mode of education in which its students, for various reasons, have opted for school dropout, Youth and Adult Education (EJA) aims to provide learning opportunities and inclusion, enabling the development of skills for personal and professional life (Silva, 2016). However, to combat school dropout and engage these students, strategies are needed to make learning more effective and enjoyable.

In this sense, the use of didactic tools and playful activities in teaching for EJA (Youth and Adult Education) students is important to promote greater interaction between the teacher and the student. This approach results in an increased interest from the classes in topics that are generally difficult to understand in theoretical classes (Heberle, 2011). The application of playful and didactic tools transforms the educational environment into an engaging space, contributing to the reduction of school dropout rates and promoting a more appealing learning experience.

The teaching of parasitology, integrated into the subject of Science, is of utmost importance for elementary school students, and the use of educational resources and innovative materials is important in this process, providing an understanding of parasites and promoting a more engaging and effective educational approach (Siqueira & Pereira, 2018).

According to Nunes and Lewandowski (2014), the study of helminthic parasitoses is important in the subject of Science to promote the health of students, but it is often treated superficially. Souza et al. (2016) also emphasize the importance of more contextualized and motivating teaching strategies to improve students' understanding and engagement with this topic.

The appropriate use of technologies can increase engagement and transform education, aiding in the intellectual development of students. By prioritizing methods that promote active construction of knowledge, technologies are presented as a simpler and more advanced alternative compared to traditional models based on books and notebooks, which often focus on memorization rather than real understanding of the content. This points to the need for a true revolution in the learning process through the adoption of these new technologies (Paula & Valente, 2016).

According to Pinheiro and Oliveira (2020), digital games in education are tools that offer great pedagogical potential, making it easier to understand more complex concepts. In this regard, Campo, Bortoloto, and Felício (2003) highlight that games are considered valuable resources for learning, as they stimulate students at different levels of social and personal experience, with the teacher acting as a facilitator and guide of this process. This allows students to acquire scientific knowledge through virtual experiences that resemble reality.

According to Oliveira, Moura, and Sousa (2015), information and communication technology (ICT) has come to revolutionize various social areas, especially education in

schools, posing challenges with tools that need to be learned and mastered by students and teachers, in addition to making classes interesting and differentiated.

Due to young people having ease with technological tools, especially in games, this resource becomes necessary in schools to make teaching creative and to develop learning (Minusi et al., 2019).

The advancement of technology and the demand for knowledge in the digital age have caused transformations in contemporary society, with computer science and new educational tools becoming increasingly essential, as information and media play a powerful role in promoting changes and autonomy, empowering individuals, society, and culture (Santos Vale, 2022).

By recognizing the importance of education for quality of life, students become agents of transformation. This awareness, both individual and collective, changes mindsets, improves living conditions, reduces socioeconomic inequalities, and contributes to the development of society.

Development

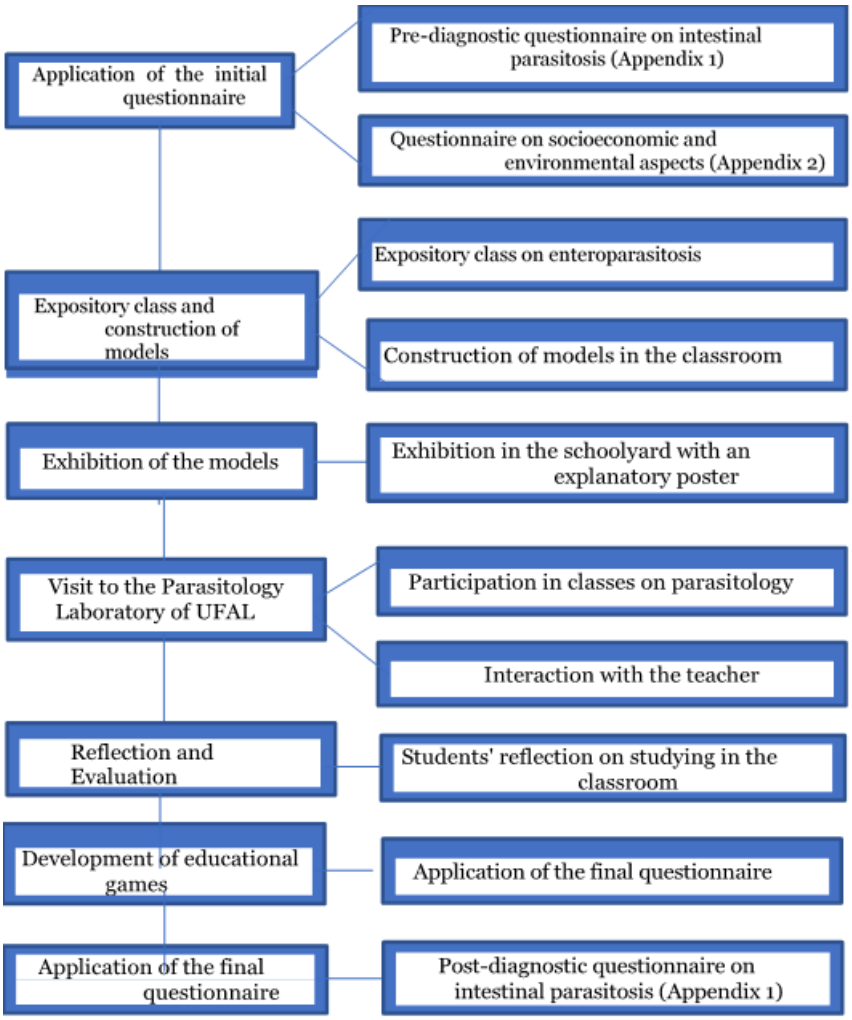
A basic, descriptive, and quantitative research, approved by the Ethics Committee in research of the CESMAC University Center, under protocol CAAE: 69091223.1.0000.0039, was conducted with EJA students at the Municipal School Dr. Pompeu Sarmento, in Maceió, Alagoas, from July 17th to August 24th, 2023. The study highlighted the importance of implementing educational actions that encourage students' interest in learning, particularly using playful methodologies, such as games. These resources were applied to raise students' awareness of the importance of a better understanding of intestinal worms and to adopt socio-environmental measures, such as basic sanitation and hygiene, which are essential to improve the quality of life and reduce the incidence of intestinal parasitic infections. Furthermore, the research aimed to promote a new mentality of self-care and health awareness, with the main goal of analyzing the socio-environmental context of intestinal parasitic infections among students.

Basic research aims to conduct a scientific investigation of a phenomenon or process, which seeks to expand the theoretical and experimental knowledge of a particular topic, without immediate focus on practical applications motivated solely by the researcher's curiosity (Creswell, 2018). The objective of descriptive research is to describe the characteristics of a population or phenomenon in a detailed manner, utilizing patterns, trends, and relationships between variables in such a way that it does not interfere with the studied environment (Saunders, Lewis, and Thornhill, 2019).

According to Creswell and Creswell (2017), quantitative research is distinguished by the use of data analysis and statistical methods, which aim for precise results. The steps of the activities carried out during the research execution are shown below (Figure 1):

Figure 1.

Flowchart of activities

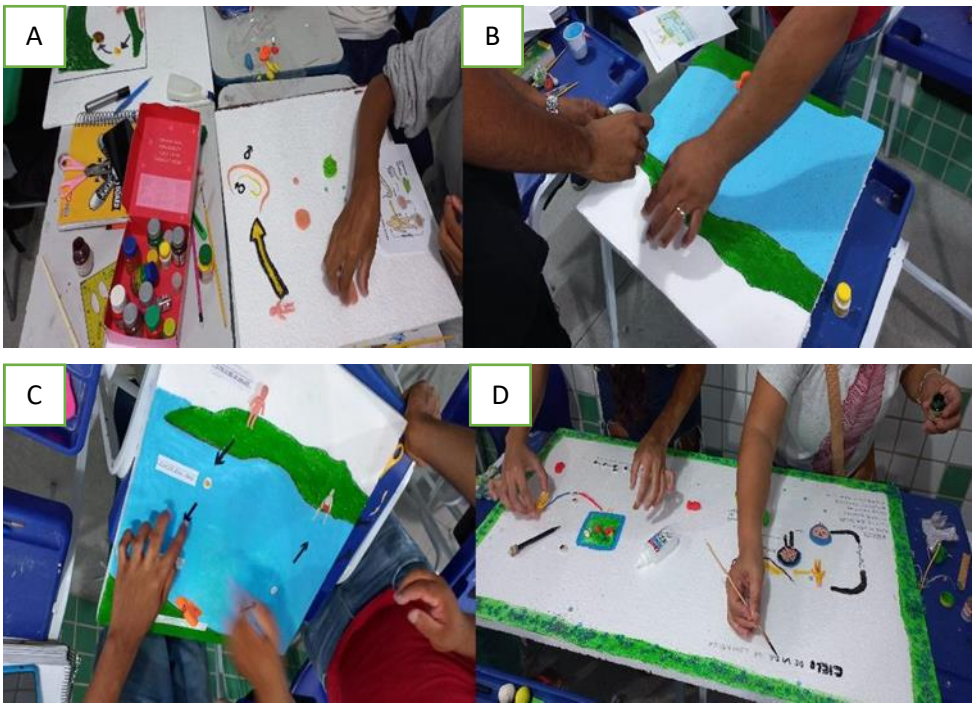


Note: The authors (2024)

Initially, a questionnaire about intestinal parasitosis (Appendix 1) and another about socioeconomic and environmental aspects (Appendix 2) was applied. Then, students from the 5th to the 9th period participated in a lecture on enteroparasitoses and the construction of models in the classroom (Figure 2), in a process that involved two to four classes of 60 minutes each. The materials used included Styrofoam, paints, brushes, among others, and interaction within the teams was encouraged to promote creativity in building the models. After the completion, the models were displayed in the schoolyard, accompanied by a poster indicating the studied helminths and protozoa. As a supplement, the students visited the parasitology laboratory at the Federal University of Alagoas (Universidade Federal de Alagoas - UFAL), where they attended classes on the subject and had the opportunity to interact with teachers. Subsequently, the students reflected on what they learned through a question answered in class, focused on learning from the models. The exhibition of the models aimed to promote the socialization of knowledge among the students and the school community.

Figure 2.

Construction of models by students in the learning process



Note: The authors (2023)

Next, two educational games were applied with the students. The first, titled "Health Villains," (Vilões da Saúde) was an online quiz made on Google Forms about parasitic infections caused by helminths and protozoa, consisting of 8 objective questions, conducted by 52 students on school computers (Figure 3). The second game, titled "Life Cycle of Intestinal Parasites," (Ciclo dos Parasitos Intestinais) developed by students from Computer Science and Veterinary Medicine using the online software Construct3, presented 6 questions with their corresponding scenes and was conducted in a computer lab with 34 students (Figure 4).

Figure 3.

Interactive quiz for deepening learning, held in the computer lab

Note: The authors (2023)

Figure 4.

Students participate in an interactive activity about the cycle of intestinal parasites

Note: The authors (2023)

After completing the stages of the study, the initial questionnaire was reapplied as a post-diagnosis (Appendix 1) to assess knowledge about intestinal parasitoses.

In this study, the use of models as an educational tool provided a practical and differentiated approach to traditional teaching. The number of students was organized and analyzed according to the corresponding period (Table 1) and classified in the following aspects: Hygiene, learning, drinking water, prevention, and leisure (Graph 1).

Table 1.

Distribution of the number of students by periods

Periods	***Number of students***
5th period	*8*
6th period	*2*
7th period	*3*
8th period	*10*
9th period	*7*

Note: The authors (2024)

Of the 30 participants, the question posed to the students: “What did you learn from the construction of the models?” received more than one answer, totaling 36 responses for all items. The item “learning” was the most cited aspect, representing 47% of the responses (n=17), followed by “hygiene” with 28% (n=10), “prevention” 17% (n=6), “drinking water” 5% (n=2), and “leisure” 3% (n=1).

In the 7th period, there was a better assimilation of the contents, with 100% (n=3) of the responses mentioning learning, including types of parasites, causes of amoebiasis, and transmission modes of worms and amoebas. In the 8th period, the learning stood out for the life cycle of the parasites and the use of models as an educational tool.

Already 13% of the 5th period students (n=1) and 14% of the 9th period students (n=1) valued the importance of consuming drinking water, unlike the other classes.

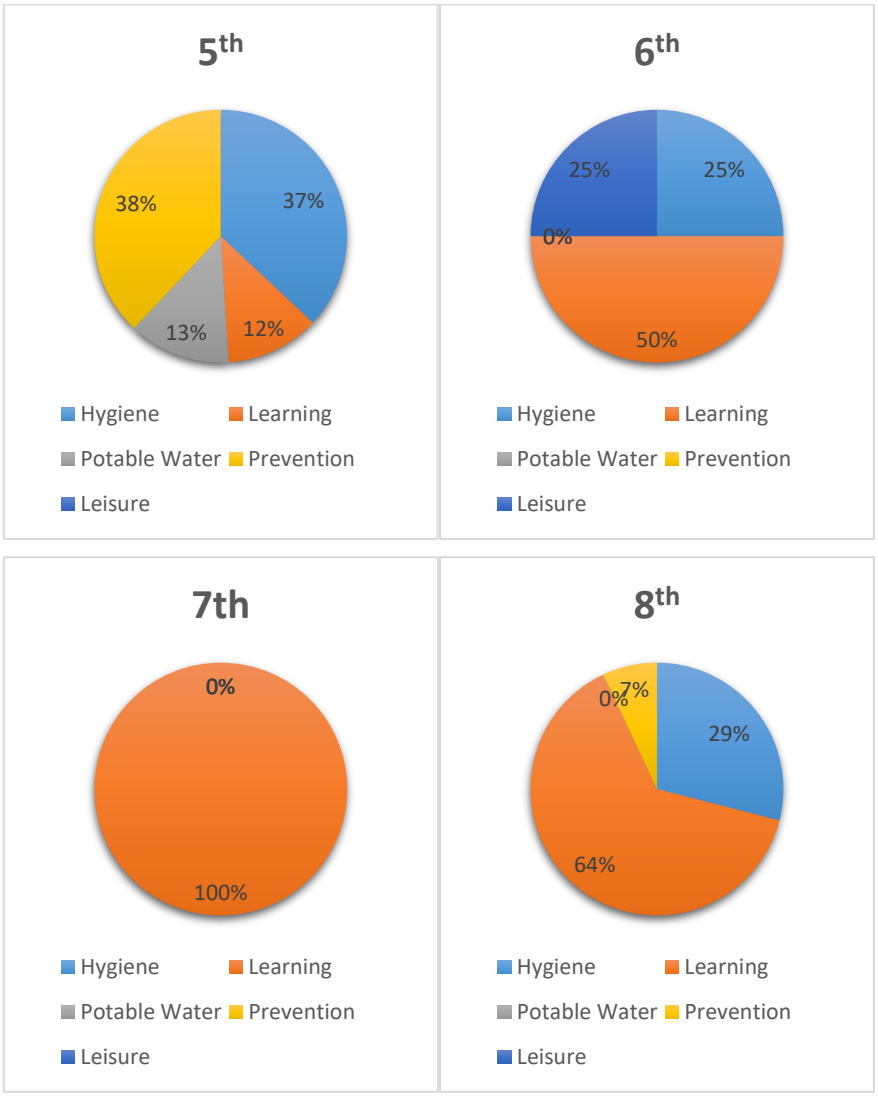
Regarding prevention, various measures were mentioned: The 5th period highlighted not bathing in contaminated rivers, not consuming raw or undercooked meat, and avoiding going barefoot, totaling 38% (n=3). The 8th period emphasized the harms of worm infections to the body with 7% (n=1). Meanwhile, the 9th period, with 29% (n=2), primarily mentioned not going barefoot.

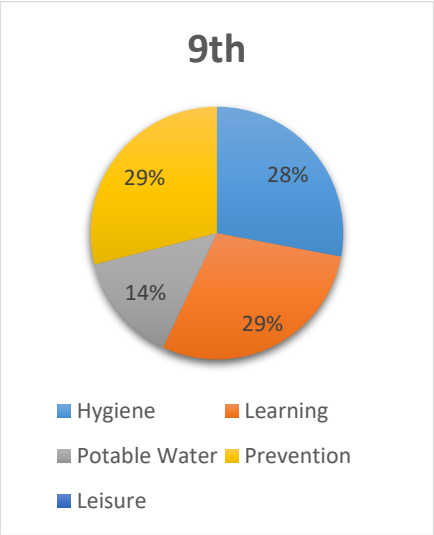
The 6th period class mentioned leisure in 25% (n=1) of the responses, particularly highlighting the construction of models as a leisure activity.

After the steps were taken, the same initial questionnaire, pre-diagnosis, was applied at the end of the process, now post-diagnosis, regarding intestinal parasitoses, as outlined in Appendix 1.

Graph 1.

Percentages of students who assimilated the knowledge transmitted in each activity they participated in





Note:The authors (2023)

The use of educational games, such as the quiz "Health Villains" (Vilões da Saúde) and the computer game "Cycle of Intestinal Parasites" (Ciclo dos Parasitos Intestinais), was explored as a learning support. The 52 students from different semesters, including 8 from the 5th semester, 2 from the 6th semester, 8 from the 7th semester, 16 from the 8th semester, and 18 from the 9th semester, were taken to the school's computer lab and completed the quiz "Health Villains" in 10 minutes.

The quiz results revealed that students showed varied performances, especially on questions 4 and 7, where 26 and 31 people answered correctly, representing 50% and 60% of the total, respectively. However, on the other questions, fewer than 50% of the students answered correctly.

Table 2.

Quiz Game: Correct questions and answers with incorrect alternatives about intestinal parasitoses

Questions	***Correct Answers***	***Incorrect Alternatives***
1. I am formed by a single cell (protozoan), I have little whips known as flagella for movement and I cause a disease known as:	Giardiasis (19 people, 36.5%)	Ascariasis (15 people, 28.8%), Amebiasis (11 people, 21.2%), Hookworm infection (7 people, 13.5%)
2. The eggs have different shapes, infertile and fertile, and are eliminated by a type of elongated worm commonly known as:	*Roundworm (25 people, 48.1%)*	*Water belly (13 people, 25%), Giardiasis (3 people, 5.8%), Amoebiasis (11 people, 21.2%)*
3. We are a couple of Ascaris lumbricoides, commonly known as roundworms; the female is larger than the male, and what is the way we reproduce?	*Sexual (19 people, 36.5%)*	*Asexual by budding (13 people, 25%), Asexual by fragmentation (9 people, 17.3%), Asexual (11 people, 21.2%)*

4. What is the shape of the body of the tapeworm?	*Flattened (26 people, 50%)*	*Rounded body (9 people, 17.3%), Triangular (2 people, 3.8%), Tubular (15 people, 28.8%)*
5. What is the host of Taenia saginata?	*Ox (25 people, 48.1%)*	*Pork (19 people, 36.5%), Chicken (5 people, 9.6%), Duck (3 people, 5.8%)*
6. Hookworm disease is an illness caused by a worm commonly known as:	*Amarelão (21 people, 40.4%)*	*Water belly (11 people, 21.2%), Chigger (12 people, 23.1%), Athlete's foot (8 people, 15.4%)*
7. Which of these diseases requires the snail to complete its life cycle?	*Schistosomiasis (31 people, 59.6%)*	*Amoebiasis (7 people, 13.5%), Ascariasis (10 people, 19.2%), Giardiasis (4 people, 7.7%)*
8. I am made up of a single cell (protozoan), I have false feet for locomotion and cause a disease known as:	*Amebiasis (19 people, 36.5%)*	*Ascariasis (11 people, 21.2%), Schistosomiasis (9 people, 17.3%), Giardiasis (13 people, 25%)*

Note: The authors (2024)

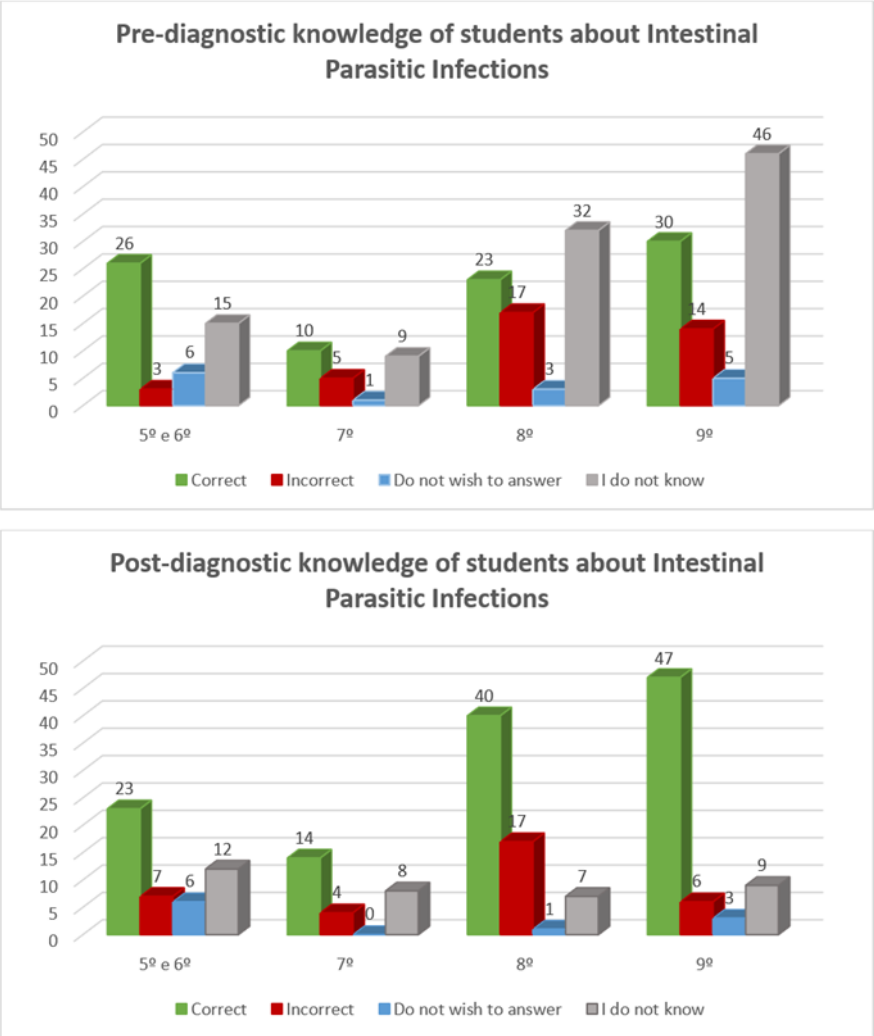
The game features a rural setting with a garden, creek, animals, and children divided into 4 clickable quadrants. There are 6 questions with corresponding scenes, where players select the correct answer. The visual elements were sourced online and adjusted for the game. Additionally, elements such as music and a score counter were included, limiting the maximum score to 6 points per game. Additional screens are displayed depending on the players' answers. The participation of the students in the game occurred individually, divided according to their class periods, including 5th and 6th grade, 7th grade, 8th grade, and 9th grade.

When analyzing the data, we noticed that a total of 52 students from all periods participated in the research. However, only 34 participated in the game. This reduction is due to the fact that the 17 absent students did not attend the class during the study period, and it was not possible to reapply due to the research deadline. According to the periods of the classes, it can be verified that: The 9th period had the highest participation, totaling 41% (n=14), followed by the 5th and 6th with 27% (n=9), the 8th with 23% (n=8), and the 7th with 9% (n=3).

The responses of the students participating in the pre- and post-intervention questionnaires in the classroom, addressing the topic of intestinal parasitosis, were compared to assess the changes in students' knowledge throughout the study. To analyze the observed differences, the chi-square statistical test was used, with a significance level of 5% (p value < 0.05). Graph 2 illustrates the evolution of the participants' knowledge before and after the educational intervention.

Graph 2.

Comparison of pre and post-diagnosis knowledge of the questionnaire applied to students about intestinal parasitosis



Note: The authors (2023)

The collected data indicate a variation in correct, incorrect, “do not wish to answer,” and “do not know” responses, as described in Tables 3 and 4.

Table 3.

Distribution of answers in the pre-intervention questionnaire (in percentage)

Period	Correct (%)	Incorret (%)	Do not wish to answer (%)	Do not know
5th and 6th	52%	6%	12%	30%
7th	40%	20%	4%	36%
8th	35%	11%	5%	49%
9th	32%	15%	5%	48%

Note: The authors (2024)

Table 4.

Chi-square test results by period

Period	Correct (%)	Incorret (%)	Do not wish to answer (%)	Do not know
5th and 6th	48%	15%	13%	25%
7th	54%	15%	0%	31%
8th	62%	26%	2%	10%
9th	72%	9%	5%	14%

Note: The authors (2024)

The chi-square test was applied to verify the significance of the changes observed in the students' responses between the pre and post-intervention questionnaires. The results are presented in Table 5.

Table 5.

Chi-square test results by period

Period	X^2	*p*-value
5th and 6th	2.08	0.5566
7th	1.82	0.6111
8th	25.78	0.00011
9th	27.69	0.000004

Note: The authors (2024).

The results indicate that the changes observed in the 8th and 9th year periods were statistically significant ($p < 0.05$), suggesting that the educational intervention had a positive impact on the knowledge of these groups. The data analysis shows that the intervention was effective in increasing knowledge about intestinal parasitosis, especially during these periods, where there was a significant increase in correct responses and a reduction in "Do not know" answers, highlighting the effectiveness of the intervention.

However, for the 5th, 6th, and 7th year periods, the changes were not statistically significant ($p > 0.05$), indicating that the approach used may not have been sufficient for these groups. Although there was some improvement in the knowledge of 7th period students, it did not reach statistical significance, suggesting the need for complementary or more intensive approaches for these groups.

An additional questionnaire was administered to assess the socioeconomic and environmental conditions of the students who participated in the research, totaling 49 respondents (Figure 5). Due to the possibility of students selecting more than one option in some questions, there was variation in the number of responses to certain questions: Question

5 (sewage discharge) with 51 responses, question 10 (presence of animals in households) with 56 responses, question 11 (household waste disposal) with 52 responses and question 15 (reported symptoms) with 55 responses.

The results of the socioeconomic and environmental conditions indicate that 39% (n=19) of the students have a family income below the minimum wage, while 27% (n=13) of the students reported an income between one and two minimum wages. This data reveals that the majority of the families of the participating students live in conditions of socioeconomic vulnerability, which can directly influence health and well-being, as observed by Sousa, Bocardi, and Cardoso (2015), who associate lower family incomes with higher rates of parasitic infections.

Regarding the type of housing, 76% (n=37) of the students live in brick houses, suggesting a certain stability and infrastructure in the communities, while the water supply comes mainly from the public network, 59% (n=29). The water used for drinking is mostly mineral, 39% (n=19), although a significant portion of the students, 35% (n=17), uses tap water, highlighting the importance of the quality of the water consumed.

Regarding basic sanitation, 53% (n=26) of the students reported that the sewage from their homes is discharged into septic tanks, while 18% (n=9) indicated that the sewage flows directly into the streets, and 8% (n=4) mentioned that the sewage is dumped into rivers. These data indicate gaps in basic sanitation infrastructure in some areas, corroborating what was mentioned by the National Health Foundation (Fundação Nacional de Saúde) (2019), which warns about the health risks associated with a lack of adequate sanitation.

Hygiene habits were also analyzed: 76% (n=37) of students reported always washing their hands after using the bathroom, and 76% (n=37) keep their nails clean. The practice of washing fruits before consuming them is common among 78% (n=38) of students. However, the presence of disease-carrying animals in homes, such as ants and cockroaches, was reported by 28% (n=16) of students, indicating a potential health risk.

Furthermore, it was reported that garbage collection is mainly carried out by trucks, with 83% (n=43) of the students indicating this, which is positive, but there are still inadequate practices, such as burning or discarding garbage in vacant lots, reported by 6% (n=3) of the students, which can lead to negative environmental impacts, as highlighted by Feitosa (2020).

The collected data reveals that students' socioeconomic and environmental conditions are closely related to vulnerability to parasitic infections and other health problems.

Low family income, lack of adequate basic sanitation, and the presence of disease vectors in homes are critical factors that need to be addressed. The presence of symptoms such as cramps, abdominal pain, nausea, and weakness reported by a significant portion of the students, 46% (n=26), suggests the existence of parasitic conditions or inadequate food, highlighting the need for more effective public health interventions.

These findings reveal concerns about hygiene and water quality, while highlighting challenges related to basic sanitation and the presence of animals in households. The integration of practical and educational activities into the school curriculum reinforces the importance of collective work, contributing to solidify knowledge and promote behavioral changes that improve the health and well-being of school communities.

This study highlights the urgent need for improvements in the socioeconomic and environmental conditions of the involved communities. Educational interventions and improvements in basic infrastructure are essential to reduce rates of parasitic infections and improve the quality of life of students (da Cruz et al., 2024). Awareness of hygiene practices and access to adequate sanitation services are crucial for promoting public health and preventing diseases.

Figure 5.

Results of the questionnaire on socioeconomic and environmental aspects conducted with the students participating in the research

TYPE OF DRINKING WATER	TAP	FILTERED AT HOME	MINERAL						I DO NOT WISH TO ANSWER
	17	12	19						1
SEWAGE DISPOSAL	PUBLIC SEPTIC TANK	RUNNING ON THE STREET	IN THE RIVER	UNKNOWN					I DO NOT WISH TO ANSWER
	26	9	4	8					3
BATHROOM	INTERNAL	EXTERNAL							I DO NOT WISH TO ANSWER
	39	5							5
WASHING HANDS AFTER USING THE BATHROOM	ALWAYS	NEVER	SOMETIMES						I DO NOT WISH TO ANSWER
	37	2	9						1
DO THEY KEEP THEIR NAILS CLEAN?	ALWAYS	SOMETIMES	RARELY						I DO NOT WISH TO ANSWER
	37	10	1						1
WASHING FRUITS BEFORE EATING	ALWAYS	SOMETIMES	RARELY						I DO NOT WISH TO ANSWER
	38	8	1						2
PRESENCE OF ANIMALS IN THE HOUSES	FLIES	RARELY FLIES	ANTS	RARELY ANTS	COCKROACHES	RARELY COCKROACHES	RATS	RARELY RATS	I DO NOT WISH TO ANSWER
	5	5	9	8	7	13	2	6	1
DESTINATION OF HOUSEHOLD WASTE	GAB TRASH	BURNED	VANK LAND	BURIED					I DO NOT WISH TO ANSWER
	43	3	3	1					2
WALKING BAREFOOT IN THE STREET?	NO	SOMETIMES	YES						I DO NOT WISH TO ANSWER
	27	12	3						7
DO YOU USUALLY SWIM IN RIVERS/PONDS?	NO	SOMETIMES	YES						I DO NOT WISH TO ANSWER
	24	10	8						7
DO YOU USUALLY EAT UNDERCOOKED MEAT?	NO	SOMETIMES	YES						I DO NOT WISH TO ANSWER
	22	11	11						5
DO YOU FEEL ANY OF THESE SYMPTOMS?	NO SYMPTOMS	COLICS AND STOMACH PAIN	NAUSEA	DYSENTERY	WEAKNESS	ELIMINATION OF ROUNDWORM	SPOTS ON VOMITING		I DO NOT WISH TO ANSWER
	21	12	8	4	6	2	1	1	1

Note: The authors (2023)

Final Considerations

The study began with the application of a preliminary questionnaire to assess the students' knowledge about intestinal parasitoses. This initial diagnosis allowed us to identify the students' prior knowledge level and served as a basis for subsequent educational interventions. At the same time, an analysis of the socioeconomic and environmental conditions of the students' communities was conducted.

The educational interventions consisted of specific classes on helminths and protozoa, covering topics such as types of parasites, life cycles, symptoms, and methods of prevention. To make learning more engaging, playful activities were used, such as building models that represented the life cycles of parasites, as well as technological resources like computer games and interactive quizzes.

After the interventions, a final questionnaire was applied to measure how much the students had learned about intestinal parasitosis. The study aimed not only to diagnose prior

knowledge and enhance preventive education through engaging lessons and activities, but also to evaluate the effectiveness of the educational strategies implemented.

The results of the study suggest that educational interventions were effective in increasing knowledge about intestinal parasitic infections, especially in the groups where the changes were significant. However, it is necessary to develop and implement complementary approaches to enhance results in groups where changes were not substantial. The evidence suggests that the use of models, games, and pre- and post-intervention questionnaires are effective teaching tools that not only promote students' understanding of the subject but also spark their interest, adding knowledge in a more meaningful way.

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