

# Exploring the Effectiveness of Digital Game-Based Learning in Tobacco Awareness Education: A Comparative Analysis of Results and Implications for Health Education

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## ABSTRACT

**Background:** Tobacco use is a major public health problem worldwide, and India is no exception. Alarming high tobacco use is seen among Indian school students. Games like No Tobacco Dash can educate them about the dangers and encourage healthy choices.

**Materials and Methods :** The Unity-based mobile game 'No Tobacco Dash' has players control a character collecting healthy items while avoiding tobacco and unhealthy items in an infinite maze. It includes character movement, item spawning, score keeping, and game mechanics. Players select one of four modules to start the game, preceded by a 30-second video highlighting tobacco's ill effects. As players advance, encountering tobacco products causes displayed lungs to fade, representing organ damage. The game ends when the lungs are fully damaged, challenging participants to progress by avoiding damage and collecting positive items.

**Results:** Results showed that for the knowledge measure, the mean pretest score was  $5.81 \pm 2.4$  and the mean post-test score was  $7.36 \pm 2.4$  indicating a statistically significant difference between the pre and post-test scores ( $p < 0.05$ ). The 95% confidence interval for the mean difference was -2.28 to -8.92. For the attitude measure, the mean pretest score was  $23 \pm 5.9$  and the mean post-test score was  $21.81 \pm 6.1$ , which was not statistically significant ( $p = 0.141$ ). The 95% confidence interval for the mean difference was -0.42 to 2.9.

**Conclusion:** In conclusion, digital game-based learning is a promising tool for tobacco awareness. Future research should explore its potential in shaping attitudes and broader health education, ultimately contributing to a healthier society.

**Keywords:** Tobacco, School students, Digital game based learning

## INTRODUCTION

Tobacco use is a major public health problem worldwide, and India is no exception. Tobacco use in any form is associated with numerous health hazards and can lead to serious medical conditions, including cancer, heart disease, and respiratory illnesses. The harmful effects of tobacco use are not limited to the individual who uses it, but can also affect those around them through secondhand smoke exposure.

Studies reveal an alarmingly high prevalence of tobacco use among school children in India. According to the World Health Organization (WHO), tobacco use among school children in India is a major concern, with an estimated 14.6% of boys and 5.2% of girls in the age group of 13-15 years reporting current tobacco use<sup>1</sup>. Another study conducted by the Global Youth Tobacco Survey (GYTS) in 2016 reported similar findings, with 10.7% of boys and 4.7% of girls reporting current tobacco use<sup>2</sup>. In addition to cigarette smoking, smokeless tobacco use is also prevalent among school children in India. Studies conducted by Narain et al., and Singh et al., reported that smokeless tobacco use among school children in India is 5.3% with relatively higher prevalence of 6.2% in rural areas<sup>3,4</sup>. All these reports indicate

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that tobacco use in any form is a significant problem among school children in India and the urgent need to address this issue.

One of the potentially effective approaches to protect school children from tobacco is to educate them about the harmful effects of tobacco use and encourage them to abstain

from use. In this digital era, digital methods, such as mobile applications and games can be an efficient alternative to conventional awareness programs and can be more acceptable to present day children. Furthermore, research has found that playing games can improve cognitive abilities such as memory and problem-solving skills. Games often require children to follow instructions, consider their actions, and respond to problems. This can help develop important thinking skills, such as awareness of the environment.

'No Tobacco Dash' is one such game that has been developed with this aim in mind. This game uses technology based innovative approaches to educate school children about the harmful effects of tobacco use and encourages them to make healthier choices.

## MATERIAL AND METHODS

### a. Design and Setting(s):

Students participated in the research with written informed consent and could withdraw from the research at any stage. Their information was kept confidential. This study was registered in the Ethics Committee of Yenepoya (Deemed to be University).

'No Tobacco Dash' is a mobile game developed in Unity, designed with the aim of raising awareness about the dangers of tobacco use. The game features an infinite maze concept where players are chased by tobacco products. The setting includes various modules covering different aspects of tobacco-related knowledge, such as nicotine addiction, tobacco-related diseases, social issues related to tobacco, and tips for staying away from tobacco. The game incorporates elements such as character movement, item spawning, score keeping, game mechanics, and level design to engage players while providing an interactive and educational experience.

### Development of Game

**Character Movement:** The first technical component of 'No Tobacco Dash' is character movement. In the game, the player controls a character that moves left or right across the screen. To achieve this movement, we used the Unity Rigidbody2D component. This component allowed us to apply forces to the character in the horizontal direction based on user input.

We detected the user input using the Input Get Axis method, which returned a value between -1 and 1 based on whether the player is pressing left or right. We then used this value to apply a force to the character in the corresponding direction.

**Item Spawning:** The second technical component of 'No Tobacco Dash' is item spawning. In the game, healthy items and unhealthy items are generated randomly and moved across the screen from top to bottom. To achieve this, we created a prefab of the items and used the Unity Instantiate method to create new instances of the item at a random position off the top of the screen. We also added a Rigidbody2D component to the items and applied a force to them in the downward direction to make them move across the screen. To ensure that items are generated at regular intervals, we used a timer that calls the item generation function at set intervals. We achieved this using the Unity Invoke Repeating method.

**Score Keeping:** The third technical component of 'No Tobacco Dash' is score keeping. The score kept track of how many healthy items the player had collected. We increased the score every time the character collected a healthy item. To display the score, we use a UI text element.

**Game Mechanics:** The fourth technical component of 'No Tobacco Dash' is the game mechanics. The game mechanics include level progression and game over conditions. At each higher level, we increased the speed of the items and increased the rate at which they were generated. We achieved this by adjusting the force applied to the items and the time interval between item generations. To implement game over conditions, we detected collisions between the character and the unhealthy items. We did this using the Unity on Collision 2D method. When a collision occurs consecutively for 3 times, we display a game over message and stops the game. We had used 3 lung symbols to show the number of collisions. Each time it collided with an unhealthy item one of the 3 lung symbol black out.

**Level Design:** The fifth technical component of 'No Tobacco Dash' is level design. The level design involves creating the visual elements of the game, including the background, characters, healthy items, and unhealthy items. We created this using Unity's 2D tools and the Sprite Renderer component. The



Fig. 1. Gameplay showing modules and tobacco products



Fig. 2. Gameplay with awareness bill boards and scoring

Sprite Renderer component allowed us to display 2D images as game objects. We also added animations to the characters and obstacles using Unity's Animator component.

**Game play Development**

The game was developed with an infinite maze concept, where the characters were chased by tobacco products. The game starts when the player selects the module. There are 4 modules namely

1. Nicotine & Addiction
2. Tobacco related Disease & Passive Smoking
3. Tobacco as a social issue
4. Tips to stay away from tobacco

Initially before the game starts, a 30 sec mandatory video is shown with the according to each module and the same is shown as bill boards inside the game while playing in orders to create an awareness against tobacco and ill effects. As the game progresses, tobacco products like cigarette, beedis, guthkha etc pop up, if the player runs into any of the negative products one of the lungs which is displayed fades off showing the damage to the organ. The game ends when the lungs are totally damaged. The task for the participant is to continue the game and progress to higher levels without losing the life by damaging the vital organs of the body rather gathering maximum positive products. (Figure 1 & Figure 2)

**b. Participants and Sampling:**

The participants in the validation study consisted of 100 student volunteers from various schools in Mangalore, ranging in age from 13 to 16 years. The sample comprised 52 boys and

48 girls. The selection of participants was purposive, aiming to include students from different schools to ensure diversity in the sample. Ethical clearance for the study was obtained from the Yenepoya (Deemed to be University), Mangalore.

**c. Tools/Instruments:**

1. Unity: The game development platform used to create 'No Tobacco Dash'

2. Validated Questionnaire: A questionnaire designed to assess the knowledge gain and attitude change of participants before and after playing the game. The questionnaire likely included items related to tobacco awareness, nicotine addiction, tobacco-related diseases, social issues surrounding tobacco use, and strategies for avoiding tobacco.

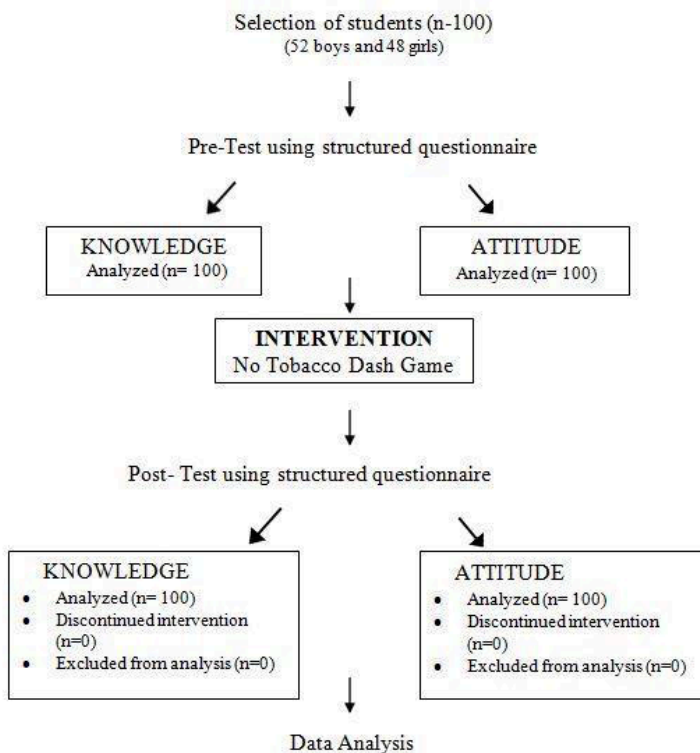
**d. Data Collection Methods:**

The data collection involved administering the game to the participants in four consecutive weeks, with each week focusing on a different module of the game. Before and after playing the game, participants completed the validated questionnaire to measure their knowledge gain and attitude change regarding tobacco use. Additionally, during game play,

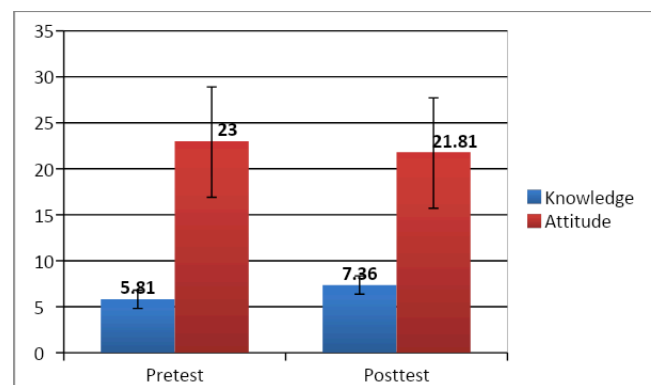
**Table 1.** Statistical analysis showed that the p value among the pre and post knowledge test were significant with t value of 4.67 and insignificant in attitude pre and post test with a t value of 1.48  
SD- standard deviation.

	Mean(SD)	t value	Confidence Interval	p value
Knowledge Pretest	5.81(2.4)	4.67	-2.28 to -8.92	0.00
Knowledge Post test	7.36(2.4)			
Attitude Pre test	23(5.9)	1.48	-0.42 to 2.9	0.141
Attitude Post test	21.81(6.1)			

p<0.05 is considered as significant



**Fig. 3.** Study process flow diagram



**Fig. 4.** Graph represents mean values of pretest and posttest of knowledge and attitude with standard deviation.



observations may have been made regarding participants' engagement, interaction with the game elements, and overall experience. (Figure 3)

#### e. Data Analysis:

The collected data was subjected to statistical analysis using paired t-tests to assess the effectiveness of the game in imparting awareness about tobacco-related issues. Paired t-tests were likely conducted to compare the participants' pre-game and post-game scores on the questionnaire, measuring knowledge gain and attitude change. The results of the statistical analysis were evaluated to determine the significance of the observed effects and to draw conclusions regarding the effectiveness of the game in achieving its educational objectives.

## RESULTS

Data were obtained from a cohort of 100 student volunteers and subsequently entered in a Microsoft Excel spreadsheet. The statistical analysis results showed that, for the knowledge measure, the mean pretest score was 5.81 (SD=2.4) and the mean post-test score was 7.36 (SD = 2.4). The calculated t-value was 4.67, indicating a statistically significant difference between the pre and post-test scores ( $p < 0.05$ ). The 95% confidence interval for the mean difference was -2.28 to -8.92. For the attitude measure, the mean pretest score was 23 (SD = 5.9) and the mean post-test score was 21.81 (SD = 6.1). The calculated t-value was 1.48, which was not statistically significant ( $p = 0.141$ ) at the conventional alpha level of 0.05. The 95% confidence interval for the mean difference was -0.42 to 2.9. (Table:1) (Figure 4)

## DISCUSSION

Digital game-based learning (DGBL) has been shown to be an effective and engaging way of enhancing students' knowledge and attitudes. The results of the paired t-test in the current study indicated that DGBL is a promising approach for improving students' knowledge of the subject matter. These findings were consistent with previous research that has reported similar results.<sup>5</sup>

When comparing our results to the studies cited, we found that there was a general consensus that DGBL is an effective method for improving knowledge acquisition and retention. Our findings aligned with those of several studies, including those by Wouters et al. (2013), Lester et al.(2014) Tsai and Nadeem et al.(2023), Papastergiou (2009), Sitzmann (2011), and Talon et al. (2020)<sup>6-11</sup>. These studies showed that digital game-based learning has a positive effect on knowledge acquisition and retention across various subject areas, including science, computer science, and education.

However, our study did not find a significant impact on attitudes towards the subject matter, which was in contrast to some of the cited studies. For instance, Yu et al. (2021)<sup>12</sup> found that game-based learning enhanced motivation and engagement, and Papastergiou (2009)<sup>9</sup> found that it improved student motivation in computer science education. Tsai et al. (2017)<sup>13</sup> also found that learners' attitudes towards DGBL could be influenced by gender and prior gaming experience. It is possible that the lack of significant impact on attitudes in our

study was due to the specific subject matter being taught or the characteristics of our sample.

When comparing and contrasting our results with those of the cited articles, there were some similarities and differences to consider. First, our study found a significant increase in knowledge acquisition and retention following the use of DGBL, which aligned with the majority of the cited studies. This suggests that DGBL can be an effective tool for enhancing learning outcomes and knowledge retention.

Another difference between our study and some of the cited studies was the subject matter being taught. For instance, Wouters et al. (2013)<sup>6</sup> examined the effectiveness of digital game-based learning in science education, while Tsai et al. (2017)<sup>13</sup> focused on the use of DGBL in a computer programming course. Our study, on the other hand, focused on anti tobacco awareness. This suggests that the effectiveness of DGBL may be subject-specific and context-dependent.

In terms of methodology, some of the cited studies used different types of games or game elements than we did in our study. For instance, Sitzmann (2011)<sup>10</sup> used serious games, which are designed to have a primary purpose other than pure entertainment, while Lester et al.(2014)<sup>7</sup> used a gamified learning environment, which incorporates game elements into a non-game context. These different approaches to game-based learning may have different impacts on learning outcomes and attitudes towards the subject matter.

Overall, these studies provide further support for the effectiveness of DGBL in enhancing knowledge acquisition and retention. While our study did not find a significant impact on attitudes towards the subject matter, the research suggests that game-based learning can positively impact motivation and engagement, which can lead to improved attitudes and performance in the long run. Further research is needed to better understand the factors that influence the impact of game-based learning on attitudes towards the subject matter.

## CONCLUSION

In conclusion, DGBL shows promise as an effective educational tool in tobacco awareness. Future studies should continue to explore the potential of digital games in addressing attitudes towards tobacco and consider the broader implications for health education. By embracing innovative approaches like DGBL, we can enhance educational outcomes and contribute to a healthier society with increased awareness and prevention of tobacco-related issues.

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