The Impact of Implementing Mobile Games into Physical Education Classes Versus Traditional Lecture-based Classes on Healthier Eating Habits in Miami, Florida

William Ruan

Stony Brook University School of Health Technology and Management

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**Introduction**

Obesity is currently a public health epidemic within the United States, with nearly one-fifth of children and adolescents ages 2-19 reporting weighing in as overweight and obese in 2017-2018.1-12 Among the 19.3% reported by the CDC, obesity rates were skewed towards adolescents, with 13.4% among 2–5 year-olds, 20.3% among 6–11 year-olds, and 21.2% among 12–19 year-olds.6 Some of the states that are top 10 in adolescent obesity rates include Florida, with children ages 10-17 reporting 17.8% and high school students reporting 14% being obese.12 It has been well established that obesity, particularly adolescent obesity, is linked to increased behavioral risks of developing adult obesity.1-5,7-11 This is because adolescence is a stage of cognitive, physiological, and social development. Choices of actions, such as eating habits and levels of physical activity, will be shape their actions and as well as their psychosocial images of themselves onwards into adulthood.7 Complications that can develop due to obesity during adolescence include increased risks of developing Type 2 diabetes, which is an epidemic of its own, diabetic neuropathy, cardiovascular disease, blindness, and psychological problems such as depression.7,9-11 While multiple initiatives were enacted to reduce the national prevalence rates over the past decade, there is still an undeniable need to address this issue and utilize modernized technologies to facilitate prevention and improve quality of life onwards into adulthood.11

To effectively curb adolescent obesity and by extension adult obesity, youths must effectively comprehend the importance of maintaining a healthy diet and practice self-care behaviors such as weight management, diet choice management, and adherence to a balanced diet.8 These habits stem from the fact that adolescents receive more than 40% of their daily caloric intake while in school, so the influence of what foods and beverages they consume are critical in curbing adolescent obesity.11 There are other social variables that can come into play in developing adolescent obesity, but diet choice is a large contributor and a highly preventable one.11 Presently, recent literature has suggested that education deployed via interactive mobile games to engage youths can successfully improve self-efficacy in adolescent obesity management.1-2,4,8 This is particularly effective, since roughly 97% of youths actively engage in utilizing the internet and as well as their mobile devices.4 This indicates a suggestive route for delivering health related messages through technology, especially due to how receptive it is with the youth.1,4 Several mobile games have used this opportunity to engage youths and address the overall obesity problem within the United States, and have been successful in small pilot studies.

While recent literature suggests that the use of interactive mobile games can induce positive outcomes with regards to healthier eating habits, the impacts of its application into the public-school systems in a high prevalence state is largely unexplored. Physical education classes are mandatory in all states within the United States to promote a higher quality of life for students. These classes are also the ideal choice in integrating classroom discussions and lectures about the importance of eating healthier diets. However, there are limited studies that explored the integration of interactive interventions into physical education curriculums to assess the effects of utilizing such methods in promoting positive diet outcomes and engagement. Therefore, more research is needed to address the paucity of implementing a large-scale intervention to Florida where the statewide adolescent obesity prevalence is close to the national adolescent obesity prevalence.

The aim of this study is to assess the impact of a 2-week integration of digital technologies, such as mobile games, in adolescents’ (ages 10-19) physical education classes compared to traditional lecture-based curriculums in public middle to high schools in Miami-Dade County of Miami, Florida, on improving healthier eating habits. This study contains an adequate number of subjects as it incorporates both middle and high school students and requires a handheld device for the gamified intervention. The intervention is economically feasible since it only modifies the physical education curriculums for two weeks, free downloads for the apps needed, and takes place during class time. Data collection is also feasible since the pre- and post-interventions surveys will be administered during class time as an in-class assignment, and the frequency of healthy meals eaten at home will be filled out as a homework assignment. Results from this study can advise resource allocations to expand the gamified nutrition education into all public middle to high schools within Florida, and lead other high obesity rate states to apply these measures.

Based on trends from previous literature, we hypothesize that the integration of interactive games into preexisting physical education curriculums will achieve higher levels of satisfaction and lifestyle engagement compared to traditional lecture-based curriculums. This is a 1-sided hypothesis because it is unidirectional, suggesting that one variable will achieve a greater value than another. Previous studies have suggested the untapped potential of utilizing interactive nutrition apps and games to engage youths and initiate the process of behavior changes.1,4 Knowledge can be disseminated more receptively in this format since most adolescents use their handheld mobile devices throughout the day and the material is delivered nonlinearly.1 Because of this, preliminary studies have reported higher rates of engagement towards self-care, which is crucial in influencing healthier eating habits.2,5

**Methods**

***Study Design***

A quantitative cross-sectional study will be utilized for this research study to explore the impact of interactive mobile games in physical education classes to promote healthier eating habits. A longitudinal study was considered but not chosen due to the short time frame of the study and freedom to elect type of curriculum. Previous studies have suggested the untapped potential of utilizing interactive nutrition games to engage youths and initiate the process of behavior changes.1,4 OneFlorida Clinical Research Consortium has found that the obesity prevalence for children (ages 2-19) is 16.9%, and among metropolitan areas to be 16.5%.3 Since most adolescents use their handheld mobile devices throughout the day and the material is delivered nonlinearly, knowledge about healthier eating habits can be disseminated in this format.1 Preliminary studies have reported higher rates of engagement towards self-care, which is crucial in influencing healthier eating habits to combat obesity.2,4-5

The 2-week program will utilize previously developed handheld games in conjunction with preexisting physical education within participating public schools. The two mobile games that will be delivered during physical education classes are “Rango Cards” and “Pick Your Plate!”. The physical education classes will follow SHAPE America’s National Standards & Grade-Level Outcomes for K-12 with a minimum of 150 minutes per week or minimum of two 45-minute sessions per week. Participating public schools will modify disseminating knowledge and skills using the games listed above. Middle and high schools will implement this program during the first week of October, and the following two weeks, or 300 minutes of PE, will be dedicated to gamified education. The first week will be for “Rango Cards” and the following week will be for “Pick Your Plate!”. During the two weeks, students will be given a take home assignment to document the number of healthy balanced meals they eat each day and record the nutrition facts based on what they ate and will be submitted to their educators by the end of the two weeks. The format will follow 35 minutes of gamified learning and open discussions about the importance of healthier eating habits. After each session, there will be a subsequent 10-minute session for a 4-question quiz with review about healthier eating habits and why eating healthier is important for their future wellbeing.

There will also be an alternative curriculum delivered in a traditional lecture-based format for the same duration, totaling of 150 minutes per week for the first two weeks. The traditional format will follow 35 minutes of lecture and open discussions about the importance of healthier eating habits. After each session, there will be a subsequent 10-minute session for a 4-question quiz with review about healthier eating habits and why eating healthier is important for their future wellbeing. Participants will receive handouts on what they learned and have the choice to review or not to review the material throughout the two weeks of PE. During the two weeks, students will be a given a take home assignment to document the number of healthy meals they eat each day and record the nutrition facts based on what they ate and will be submitted to their educators by the end of the week.

|  |  |  |
| --- | --- | --- |
| **Course** | **Time** | **Activity** |
| Week 1: Rango Cards | 35 minutes | Game |
| 10 minutes | Multiple choice quiz |
| Week 2: Pick Your Plate! | 35 minutes | Game |
| 10 minutes | Multiple choice quiz |
| Week 1: Traditional | 35 minutes | Lecture |
| 10 minutes | Multiple choice quiz |
| Week 2: Traditional | 35 minutes | Lecture |
| 10 minutes | Multiple choie quiz |

**Figure 1.** *Curriculum timings for the first two weeks of October for both gamified and traditional physical education classes.*

***Setting***

This study will take place in during physical education classes in middle and high schools in Miami-Dade County in Miami, Florida. Physical education classes are required to have at least 150 minutes per week in Florida by state stature, and these schools will follow through that minimum. Participating schools will adjust their curriculums for two weeks to integrate the gamified education. Transportation will remain as it is since it takes place during normal school times.

***Participants***

Recruitment will be initially conducted through the Department of Education within Miami, Florida. Participating schools will have the ability to participate in the gamified education or retain the traditional education. Since majority of the students that will be participating in this study are under the legal age of 18, legal guardian consent will be asked. Participants have the right to withdraw from the study at any time, and their results will be excluded. They will still be required to attend physical education classes as part of the school’s requirement.

The inclusion criteria will include the following: participants who are ages 10-19, participants who are enrolled in public middle and high schools in Miami-Dade County, and participants with smartphone or mobile devices capable of downloading the apps needed. Participants who are enrolled in charter or private middle schools within Miami-Dade County will be excluded. Participants who have clinically diagnosed developmental and/or cognitive disabilities will be excluded for data collection but will have the choice of attending the gamified physical education modification. And finally, participants who do not attend one or more of the physical education classes during the first two weeks of October will be excluded from the data collection.

***Variables***

The outcomes of healthier eating habits will be assessed in a 14-question questionnaire, which will ask participants to choose between 1-5 on a Likert Scale (1: never, 2: rarely, 3: sometimes, 4: often, and 5: always). Participants who chose 1-2 will denote low outcomes. Participants who chose a 3 will denote medium outcome. And finally, participants who chose 4-5 will denote high outcomes.

|  |  |
| --- | --- |
| Average of 1-2 | Low outcomes |
| Average of 3 | Medium outcomes |
| Average of 4-5 | High outcomes |

**Figure 2.** *Numerical scores and their categorical outcomes used in this study.*

The three main variables will be assessed from the take home assignment over the two weeks, and these are fall under: types of diet, consciousness of diet, and diet control. For types of diet, we will measure the frequency of the types of diet students eat for breakfast, lunch, and dinner. This includes seafood, fruits/vegetables/legumes, cereal/bread/oatmeal/pasta/rice, and dairy products. For consciousness of diet, we will measure the frequency of eating out at fast food restaurants, consuming carbonated sugary drinks, reading at nutrition facts before purchasing each item, and drinking/eating low-calorie/low-sugar/low-sodium/low-fat alternatives. For diet control, we will measure the frequency in resisting eating fast foods, purchasing unhealthy snacks, eating unhealthy snacks, and eating three meals a day.

|  |  |
| --- | --- |
| Types of diet | Fish/seafood |
| Fruits/vegetables/legumes |
| Cereal/bread/oatmeal/rice/pasta/noodles |
| Dairy products/cheese/yogurt/milk |
| Consciousness of diet | Eating out at fast food restaurants |
| Consuming sugary drinks/carbonated drinks |
| Reading nutrition facts when purchasing food |
| Drinking/eating low-calorie/low-sugar/low-fat alternatives |
| Diet control | Resisting fast foods |
| Purchasing unhealthy snacks |
| Eating unhealthy snacks |
| Eating three meals a day/skipping meal |

**Figure 3.** *Categorical variables that will be assessed in this study.*

***Data sources/measurement***

A 12-question survey will be given to assess student report outcomes for healthier eating habits through a Five-point Likert Scale during class. The questions will be closed and include structured answers. This questionnaire will be delivered in person before the start of and after the program. Likewise, data collected from the two weeks take home assignment, as seen in Figure 3, will be compounded, and analyzed to see how often participants eat healthier meals during the 2-week course of both gamified and traditional education curriculums

***Bias***

There may be a selection bias which will lead to a sample that does not provide a generalizable sample of the adolescent population in Miami, Florida. The integration of digital technologies may be only effective for those with mobile devices that can handle it. Student participation in the gamified physical education course will have different incentives depending on the school and grade level. Pedagogy will vary due to the different number of schools participating and the age groups that needed to be catered to. And the comprehension of the material given can be affected as there is a literacy gap between middle to high schools

***Study size***

The recruitment period will end after all the middle to high schools have submitted their choice of participation or lack thereof. The maximum enrollees per physical education class will be 60 students.

**Results**

The dataset utilized for analysis was retrieved from the CDC’s National Youth Risk Behavior Surveillance System (YRBB), and it showcases the nutrition, physical activity, and obesity prevalence among youths within the United States from 2001 to 2019. This dataset was published back on July 22, 2016, but it was recently updated on January 29, 2021. Due to the nature of this dataset, there were both categorical and numerical values assigned to each observation. Prior to cleaning this dataset, there were 1000 observations and 31 features. The dataset was cleaned and filtered to remove redundant and null values that may obscure the statistical analysis. An analysis of this dataset can shed light in each state’s prevalence rates and demonstrate a comparison between the state of interest to national averages.

The dataset was analyzed using Python and Pandas library via the Google Colab’s jupyter notebook. As mentioned previously, the dataset required transformations to turn it into a usable format via locating missing values and dropping features that were redundant or not useful to the analysis. An initial null summation was used to check the total number of null values per feature, and it was found that there were a substantial number of missing data. While looking at all the states and its attributed values, the US was included within the dataset. Any value that was associated with the US observation was dropped to prevent confusion since all the other values were from the 50 states. There were also non-null values for features that were not useful for the analysis, so features such as ‘data\_value\_alt’, ‘data\_value\_footnote’, ‘data\_value\_symbol, and ‘topic’ were removed. The features listed above provided no significant value nor did it bring any information that was not already stated within the dataset. After cleaning this dataset, there were a total of 940 observations and 23 features.

The cleaned dataset was filtered into two data frames. One of them shows the national adolescent obesity rates while the other shows the Florida state adolescent obesity rates. An analysis of the national dataset brought forth valuable information in terms of outliers, skewed data, participant demographics that is useful for potential target of intervention, and support for previous literature indicating the relatively high prevalence of adolescent obesity within all 50 states. Visualizations were conducted by importing Seaborn, Matplotlib, and Plotly libraries into Google Colab. Based on the boxplots in Figure 4, there are several outliers in the percentage of adolescents reporting having adolescent obesity within the United States. These can be identified in the points on the axis.

Florida state will be the focus of this study and therefore, all observations containing obesity status within Florida were compounded into one table as seen in Figure 6. The table was ordered based on the year the data was collected and the total percentage of reported obesity is shown on the right. Results collected from this data frame indicated repeats of studies of the same year from different sample groups but suggests an overall downward trend of adolescent obesity. This can be visualized on Figure 8. An analysis of the central tendencies of the obesity status data collected within Florida can be seen on Figure 7. Data on the intake of sugary drinks in Florida was also analyzed, but there were numerous missing data that made it difficult to correlate with the trends observed in obesity with confidence. This can be visualized in Figure 11.

A separate data frame was created to compare Florida’s values across the rest of 49 in the United States. The central tendencies can be shown in Figure 9, and indicates that the national obesity rates are still higher than Florida’s. A combination of Florida’s chart and the national obesity rates were placed together side by side as seen in Figure 10. Overall, the national adolescent obesity is rising but slowly across all 49 states while Florida is decreasing. This indicates that there are positive outcomes with current initiatives to curb and prevent adolescent obesity within Florida. If the initiatives are continued, Florida’s statewide adolescent obesity should decrease towards 10% over the next couple years. The national data, however, suggests that adolescent obesity persists throughout the United States. New interventions that are more engaging to youths to curb adolescent obesity will be needed to combat this issue. The shaded regions as seen in Figure 10 indicates the standard deviations within the data frames chosen.

Despite transforming the dataset into a usable format, an unresolved issue that remained was the inability to create visualizations showcasing the race ethnicity variables with obesity. When the data was cleaned, there were a lot of NaN values that proved to be insignificant and skewed the presentation of the data. Due to the lack of time and coding knowledge to resolve this issue, this feature was not transformed. Visualizations that linked these two were not conducted nor included in the final Google Colab file.

Chart, histogram

Description automatically generated

**Figure 4.** *Boxplot for adolescent obesity of the 50 states.*

**Graphical user interface, application

Description automatically generated**

**Figure 5.** *Boxplot for adolescent obesity of Florida.*

Table

Description automatically generated

**Figure 6.** *Table representing all the values containing obesity status within Florida collected.*

Table

Description automatically generated

**Figure 7.** *Descriptive table of adolescent obesity rates in Florida*

Chart, line chart

Description automatically generated

**Figure 8.** *Line chart that shows Florida’s adolescent obesity rates over time.*

Table

Description automatically generated

**Figure 9**. *Descriptive table of adolescent obesity rates in the United States excluding Florida.*

Chart, line chart

Description automatically generated**Figure 10.** *Combination line chart that compares the National adolescent obesity rates to Florida state over time.*

Chart, line chart

Description automatically generated

**Figure 11.** *Combination line chart that compares adolescent obesity rates in Florida with the state’s reported intake of sugary drinks from adolescents.*

**Conclusion**

This research study was designed over a course of 6 weeks with the following steps in mind: designing a research question, choosing a research design that befitted this question, finding a dataset that pertains to the question, analyzing the dataset, and interpreting its results. The initial step of creating this research study required one to find a clean slate—an area that is circulating but not too much that you can’t find your niche. To achieve this, one must delve into concurrent literature to develop a question that is followed PICOT and a research design that followed the FINER models. That is, the question must be specific to include population, intervention, comparison, outcome, and time. The research design must also be feasible, ethical, novel, interesting, and relevant to the scientific community. Therefore, choosing a design and subsequent method to answer the initial research question requires extensive planning and analysis between researchers. Following the development of methods, dataset selection was arguably the hardest part. Since my research question was about the assessing the effects of integrating handheld mobile games into physical education classes compared to traditional physical education classes on healthier eating habits to combat adolescent obesity, I had to find datasets that pertained to such topics. However, the only datasets that I could find were the YRBB dataset from the CDC, which only included data on adolescent obesity rates across the 50 states. This dataset chosen for analysis only showed the prevalence values of obesity status and had a lot of missing data to correlate with. As such, this dataset did not produce valuable insights for the impact of gamified education in physical education classes. There were also a lot of missing data that made it difficult to correlate the features together. Analysis of this data was slightly difficult due to the lack of knowledge in both coding and data analyzation tools but was doable with the help of Stack Overflow and other evidence-based tutorials. However, despite its limitations, this dataset demonstrated the continued need to create initiatives to engage youths better in combating adolescent obesity. Florida is seemingly showing positive outcomes with a regression from its all-time high in adolescent obesity rates, but the nation is lagging in that momentum. Developing a curriculum that integrates the use of digital technologies to educate about healthier eating habits can only be part of the pie that can impact adolescent obesity.

Due to a lack of coding knowledge and the complex codes that can be added to improve not only the data cleaning process but data visualization, the showcasing of the filtered data was limited to line charts, bar graphs, and box plots. With sufficient time and knowledge, future data visualization and cleaning can include an interactive map of Florida that features multiple datasets and other compounding variables that can explain the adolescent obesity prevalence rates. A 3-D scatter plot was created using Plotly but it was not successful in demonstrating conclusive results. Future actions for this data set would be possibly finding updated datasets with race and ethnicity or merge it with future datasets that contain adolescent physical education intensities.

Although this research study was designed under the assumption of unlimited resources, a potential issue when conducting this in real life is the organization of the very schools that are participating. Because the public school system is large, it can be difficult to create a unified teaching curriculum across both middle and high school students. Certain schools may also lack the proper resources, such as having every student to own a smartphone device, to conduct this study, even if it is proved to be successful in impacting students’ eating habits. However, if this is possible to conduct in real life and shows positive outcomes with both adolescent engagement and healthier eating habits, it will not only add to the current literature, but lead more research to be conducted across the nation as an effort to curb adolescent obesity as a whole.

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