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A Moral Education Learning System based on the Snakes and Ladders Game

E.O. Ibam[1,*], T.A. Adekunle[2], O.C. Agbonifo[1]

[1] Department of Information Systems, School of Computing, Federal University of Technology Akure, Nigeria
[2] Department of Computer Science, School of Computing , Federal University of Technology Akure, Nigeria

Abstract

Moral decadence in our society rises more and more and complaints about this issue are oftentimes about children and their future. Children are likely to disobey due to their inability to understand the effects of their decisions. Games liked by children can help in child education, especially when the moral aspects of such games are well highlighted. This paper reports the development of a Snakes and Ladders game that emphasizes the moral aspect of the game approach in order to promote moral education among children. The game was tested on twenty (20) children between the ages of 6 and 7. Their knowledge and willingness to follow moral and societal rules was tested before playing the game multiple times and also tested thereafter. It was observed that their knowledge and willingness to follow the rules improved. The game works subconsciously in helping children understand the consequences of certain moral actions in a virtual way.
The Design of the system consists of the system architecture, the Use Case diagram, and a flow chart which explains all procedures in a logical sequence. A mathematical model and an algorithm are used to describe the gaming process.
The system is implemented using Java programming language.

Keywords: Moral Education, Games, Snakes and Ladders, Character, Players, Behaviours, Winner.

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*Corresponding author. Email:eoibam@futa.edu.ng

1. Introduction

A Snakes and Ladder Game is a traditional board game played by one to four people. The game is based on the movement of the characters of these players along numbered boxes and the first character to get to the last box wins. The players' characters progress by throwing a die, the number on the die determines how many boxes the player moves. There are snakes and ladders on the way; snakes take a character backwards (or downwards) while the ladders lift up the characters thereby adding a fun twist to the lucks of the characters.

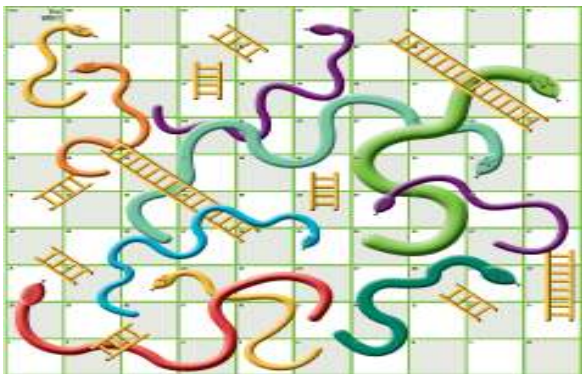

Figure 1. A Traditional Snakes and Ladders Game Board

Snakes and Ladders game is simple, easy enough that a child can play (see Figure 1). Despite this the mathematics of this game – especially with regards to Markov chains - are quite interesting [1].

In an interview with the Big Think [2], Diane Ravitch, a United States' educational historian, said that contrary to conventional wisdom, it is not the kindergarten teachers who are most responsible for kids' progress - ages 0 - 5 are some of the most developmentally important, with continued resonance throughout one's entire life. Before they have ever set foot in school, there are dramatic developmental differences between children, and these differences often fa1l squarely along socio-economic lines. What Ravitch, the Assistant Secretary of Education under President George H.W. Bush, was trying to say, is that the development of kids starts from home. Charity, they say, begins at home. A child begins to learn morality, social comportment, and several other developmental traits from home, and not until he/she gets to school.

Although they are receptive to instruction as they are in, as scientists noted, their 'sensitive period' [3], they might not completely understand the reasons behind certain rules they might have to follow. Hence, the needs for a visual but virtual and inexpensive way of making them understand. According to [3], the sensitive period for learning manners and courtesies in a child's development is 2 to 6 years, and this coincides to the age they begin to read (i.e. age 4.5 to 5.5). Therefore, by the age of 6 they are the most receptive to this implementation.

Children need a more fun way to learn the differences between good and bad and their consequences. Snakes and Ladders started as a Hindu board game called *Leela* [4]. The game taught an important lesson; good deeds take you up, bad deeds take you down. At the bottom of the ladders good deeds like "hard work" is written which would lead up to "success" and bad deeds like "disobedience" would be written at the mouth of the snakes which could lead down to "bad luck".

It is obvious in our communities that moral standards among children are degrading more and more. Nowadays, children do not just take to simple instructions by their parents and/or leaders in the community. One could be tempted to say they have never actually experienced the repercussions of wrong behaviours and by the time they experience this, it may cause irreparable damage.

Children can learn about "rewards and sanctions" related to their choice of behaviours normally as they grow over time, but experiencing a practical example makes them take such lessons more seriously. Going down the length of a snake and therefore losing the game because their player character landed on a square labelled "Stubbornness" helps them understand what happens if one chooses to be stubborn. Therefore, with this game, good habits are formed in them at a very young age, and prepares them for a better future.

The work of [4] was a key motivation to carry out this work. The snakes and ladders game has become just a game and the learning aspect of the game has been largely neglected. The history of the game speaks for itself and now this same game would be used for what it was originally designed for: to educate kids.

[5], an online news magazine reported about a recent survey by the Pew Internet and American Life Project per the Horizon Report, where they found that massively multiplayer and other online game experience are extremely common among young people and that games offer an opportunity for increased social interaction and civic engagement among youth. The phenomenal success of games with a focus on active participation, built in incentives and interaction suggests that current educational methods are not falling short and that educational games could more effectively attract the interest and attention of learners.

The survey cited above formed another motivation for this work. Since the Snakes and Ladders game is also a multiplayer game, it is reasonable to that, it can help children, especially introverts, interact socially and be able to carry out their civic engagements very actively in cooperation with others

2. Related Works

[6], presented a case discussion for moral educations at the first half of the twentieth century and later. From the start of the twentieth century, classroom instruction focused more on civic and moral virtues. Later on, the dynamic changed and the educational community lost interests in virtues and morals. It has been evident in recent times that neglecting a child to be taught cogent issues on morality and civility would be cataclysmic. It therefore, falls on the parents, like it should ever be, to educate their children about morals. [6] also offered alternatives to moral education and one important option among other options centres on training them at home by reward and punishment. The Snakes and Ladders Game offers a good fun-filled and practical way of virtualizing or simulating reward and punishment for good and wrong doings respectively.

The Snakes And Ladders Game has pervasive purposes, especially in the scientific world. It has been used in explaining Markov Chains, because the odds of a player landing on a new square is fixed and based on the current position of the player and never on any previous position [7].

Snakes and Ladder could also be treated as an impartial game in combinatorial game theory even though it does not at all fit this category [8]. Therefore, a modification, Adders and Ladders was created which had a few alterations to the rules of the original game. The latter requires mastering skills other than relying solely on luck.

Milton Bradley, a snakes and ladders board game manufacturer has in his version, a hundred labelled squares, with 19 chutes and ladders. According to [9], a player will need an average of 39.6 spins to move from the starting point which was off the board to the 100th square. A two-player game is expected to end in 47.76 moves with a 50.9% chance of winning for the first player.

[10] used the concept of Snakes and Ladders to expound the attributes of statistical programmers. As statistical programmers forge their career and enhance their skills, they move up the hypothetical ladder. As statistical programmers progress, they encounter opportunities and 'ladders' that make them bigger. However, in their relationship with statisticians, there could be some rifts in case of any perceived hierarchy in career status and opportunities which could jeopardize the strong relationship that already exists between them in a given organization (the snakes).

[11] recognized the noninterest of students to learn Jawi script, a Malay language using Arabic characters. They therefore took the edutainment approach by using Snakes and Ladders to encourage both students and teachers to reach an acceptable level of interest and understanding. The authors also recognized that there has been a lack of any educational game based on teaching Jawi script. The game was created and was tested by both students and teachers and the result was successful.

[12] present Snakes and Ladders as a medium of teaching and learning mathematics and proves it enhances cognitive development of students with learning difficulties. The objective of their work was to examine the use of snake and ladder game as a learning medium for those students with these learning difficulties. The study used qualitative methods. Data was collected by observation of the game that has been conducted. The respondents for this study involve five students in a school which have learning problems. Observation and outcome of data were analysed in order to make the researchers more convenient in gaining the information.

The usage of snake and ladder game in enhancing the cognitive development of the students with learning difficulties in learning Mathematics was presented.

[1] discussed the use of Markov Chains to analyse and develop a theory of Chutes and Ladders, also known as Snakes and Ladders. A computer program was also written to simulate the game while experimenting with the rules and layouts. The objectives were to analyse the theory of Markov chains, develop a theory of the board game, write a program that simulates the game, tinker with some rules and layouts and see the effects on the game. The theory of Chutes and Ladders was built using Markov Chains. Computer programming was used to model the chutes and ladders. Experiments were then performed on the rules and layouts to derive counterintuitive results. The contribution include: a developed theory of chutes and ladders, an absorption of Markov Chains and understanding what happens when some rules or layout are changed.

[7] presented a simple board game used in an introductory course in AI to initiate students to the gaming experience issue. The game was modified to provide different levels of challenges for students.The objective was to solve some issues that occur in the lessons learnt from board games. It is usually used to explain decision algorithms in AI but the actual gaming experience of the players are often left out. The authors set out to make the game more challenging for students in the theoretical, algorithmic and programming aspects. Markov Decision Processes (MDP) were used to present the solution to the problem mentioned above. MDP solving algorithm is used to compute a policy for an autonomous intelligent agent that adjusts its difficulty level according to its opponent's skill level and a modified version of the snakes and ladders game is used as testbed. There contribution include: a more challenging game of snakes and ladders where the players gets to make decisions and the introduction of an intelligent computer-controlled actor that can change its level of challenge depending on how good the user is.

Other journals and books have been published which in different ways discuss the Snakes and Ladders or a related game, especially as a practical example of Object-Oriented Programming using several programming languages; some scientific experiments were also made.

3. System Design

Here, the features and components of the snakes and ladders game are explained. How it incorporates morality for children is also expounded. The architecture of the system which shows the different components of the system is discussed; the Use Case diagram which shows the users' interaction with the system is also shown. Overall, a flow chart diagram which explains all procedure in a logical sequence is also presented.

3.1. System Architecture

The system composes of four different components which are the interface, die, characters and database (Figure 2). They all work together to form the functioning whole and give players a real-time experience of the game. The interface represents the board and general environment of the game. It also performs the morality function and enforces the rules of the game. It informs the players what they have notionally done wrong to have gone down the length of a snake and what they have done right to climb up the ladder. Although this is just a simulation of character and behaviour, children can still get the goal. The die is one random number generator which is from one (1) to six (6) and with the aid of the interface has a graphical representation. The characters are a representation of the players on the board and how they move on it, they are shown in form of different colours. The database stores the progress of the game and keeps

track of the best players by ranking them by the number of moves it took them to win.

Figure 2. Architectural Diagram of the System

3.1.1 The Interface

When the game is loaded, the interface begins with a menu page. It shows options available to the user(s) which include 'Play', 'High scores', 'Settings', 'About the Game' and 'Quit'. Each button leads to a respective screen. The 'Play' button leads to the game board for the game to start, the 'High scores' button displays the list of high scorers with the number of moves it took them to win while the 'Quit' button quits the game. Following a click on the button, a confirmation dialogue is displayed first and based on the user's choice of action, an execution is carried out.

On the game board, each user can choose the colour of their character. Each character moves on the board when the user clicks on the die. The number on the die determines the number of steps the character moves. If the character lands at the feet of a ladder, the interface generates a sentence from the database stating why the character will climb up the ladder. For example, a message such as "You ran an errand for your mother, move up to 25" could be displayed. In the same vein, if the character stops at the mouth of a snake, a sentence is generated by the interface, an example of such is "You beat your younger brother, go down to 18". The first character to reach the 100th box wins the game and if the number of moves it took ranks lower than the highest on the list of high scores, it is inserted at the appropriate position. Data for the high scores window is generated from the database.

3.1.2 The Database

The database acts as a repository for all the morality stories of the game and the gaming statistics as well. It consists of several relations, one of which is the table of best winners. This table is a list of winners ranking them by the number of moves it took to win. Relevant fields in this relation are "Name" and "Number of Moves". The relation is automatically populated as a winner emerges after each game but the limit is set at 10 entities at a time. Therefore, after there are ten winners, the next set of winners either eliminate a winner already on the list or do not make the list at all.

The most important part of the database is the back-story of the game. It acts as a knowledge base for the lessons on morality of the players. The hypothetical actions of the players and its effect are stored therein. There are ten ladders and ten snakes and for each ladder and snake there are five statements for why the player goes up or down. For each time a player lands on the foot of a ladder or mouth of a snake, any one of the five statements pop up on the interface at random. These statements would be sequential to the game. That is, to make the game more interesting, each of the statements contributes to a storyline that is enjoyable to the age group.

The database interacts directly with the interface and provides the interface with relevant data as requested by the user.

3.1.3 Random Number Generator (RNG)

It is represented by a die on the interface. All it does is generate numbers from 1 to 6. The RNG determines how long each character moves. When the player whose turn it is clicks on the die, the Random Number Generator is called. When called, it gives a random number from 1 to 6.

3.1.4 Characters

They are a representation of the players, distinguished by colour. Each player makes a choice of character depending on the character they desire (Red, Green, Yellow and Blue). The characters are depicted by the interface and they move along the squares that form the board. Therefore, these characters show the progress each player makes on the board during the game. When a player reaches the foot of a ladder, the character climbs up the ladder to the top, likewise, when a player reaches the mouth of a snake, the character slides down the body of the snake down to the tip of its tail. The first character to reach the 100th square wins the game. Once a user chooses their character, they cannot change the character any longer until the end of the game. This is to prevent confusion of the other players.

3.2. Use Case Diagram

Use case diagram shows the interaction of the players with the game. Before the start of a game, a single user makes decisions and interacts with the system. The user

can choose to start a game, check high scores, change the settings of the game or quit the game. When a new game is about to start, all players have equal control over the game. They can choose their respective characters and roll the die.

Before a game starts, only one user can interact with the interface. This takes place before they are split into different characters. The possible interactions as shown in the diagram are Play Game, Check High Scores, Change Settings and Quit.

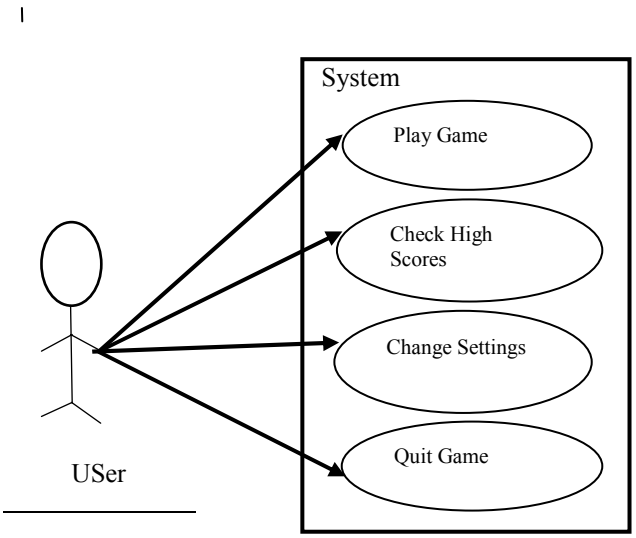

Figure 3. Use Case Diagram of the System

Table 1. Actions of a single user and their meanings

Actions	Meaning
Play Game	Starts a new game
Check High scores	Shows a list of the top 10 players of the game in an ascending order of number of moves
Change Settings	Allows the user to change some settings such as turning on or off the sound
Quit	Quits the game after a confirmation

When the game is about to start, each player is able to Choose a Character they wish to. This is one of their interactions with the game. They also Roll the Die for their character to progress with the game.

Table 2. Actions of Multiple players and their meaning

Actions	Meaning
Choose a character	Chooses a pictorial representation of the player on the board
Roll the die`	Rolls the die to execute the random number method and generates a number from 1 to 6

3.3. System Flowchart

The flow chart is a diagrammatic visual representation of the algorithm, workflow, sequence of steps and decisions needed to implement the Snakes and Ladders program, and is shown in figure 4. This representation illustrates a solution model to the Snakes and Ladder problem. It shows is how the game 'flows' from one stage to another. Furthermore, it shows the decisions to be made while playing and the implications of those decisions.

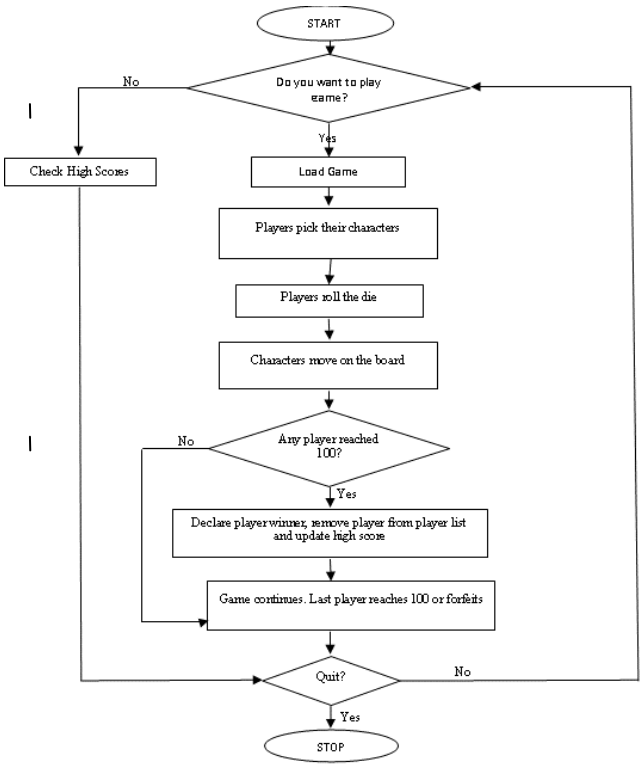

Figure 4. Flowchart Diagram of the Snakes and Ladders game

3.4. The Database Design

The game database has several relations, each of which performs its own functions, even though most of them have similar functions. The backstory to the game has been preloaded into the database. Statements that form the story drawn from the database in the game are called 'Stories'. For each snake and ladder, there is a choice of at least five stories. More than one story is stored mainly to prevent the game coming up with the same stories every time the game is run. There are ten snakes and ten ladders in the game, therefore there are twenty relations holding at least five stories each. Each of the stories state a hypothetical action the player has taken and a repercussion of such action (go up or go down). Each of the tables for stories have entirely the same fields but different content.

There is also a relation for high scorers. This table is empty at initialization and becomes populated as the game is being played. It can only hold ten instances of data at a time. The relation is sorted in an increasing order of number of moves it took to win. When the ten available spaces are filled up, for each game played, the number of moves it took to win the game is compared with the number of moves the tenth ranked winner on the high score list. If that of the current winner is less than that on the list, then, the current winner displaces the last on the list and is ranked in the database in an increasing order of number of moves. The fields of the relation are shown in tabular forms below.

Table 3. Table of story

Field Name	Field Type	Field Length
Id	Int	1
Story `	Text	

Table 4. Table of High scores

Field Name	Field Type	Field Length
Id	Int	2
Name	Varchar	20
Number of Moves	Int	2

The ID field in both tables represents the primary key, although in the high score table, the key is not shown when view from the game interface. In the table of stories, the ID for each story in a table is fixed. On the part of the high scores table, ID is set to auto-increment. Therefore, for every new entry into the table, a new ID is given automatically regardless of the position of said entry in the table. This means that an entry could be the first one in table while carrying an ID of 10. This means that the entry is the tenth one to make it into the database, but has the lowest number of moves value, because the table is being sorted in an increasing order of number of moves.

The Story field in Table 3 holds the proclamations of its corresponding ladder. The stories to be displayed are stored here. The game picks any one at random and displays it to the player. It has a 'text' data type and was not given any limit to its length.

In Table 4, the Name field holds the name of the player. Before the game starts, each player inputs their name and by the end of the game, if the winner makes the cut, the name enter is stored under this field. The Number of Moves field is simply the number of movers it took such winner to win the game. Since the player with the lowest number of moves is the best, the game is ranked from lowest to highest, therefore, whoever has the lowest number of moves in the game tops the high score table.

Even though the number of moves a player has is lower than any on the list of high scores, if the player did not win the game, the player would not be added to the list.

3.5. Modelling of The Gaming process

The movement of the characters on the board can be represented in a mathematical form. The board is square with a dimension of 600x600 pixels with 100 square boxes forming a 10x10 matrix. Since there are 10 boxes on each row and 10 boxes on each column, each box has a

dimension of 60x60 pixels. The boxes are labeled from 1 to 100 as shown in the sparse matrix below.

$$\begin{pmatrix} 100 & \cdots & 91 \\ \vdots & \ddots & \vdots \\ 1 & \cdots & 10 \end{pmatrix}$$

The movement of the characters along the boxes is a form of zigzag manner. That is, on the 1st, 3rd, 5th, 7th and 9th row, the characters move from left to right and on the 2nd, 4th, 6th, 8th and 10th row, the characters move from right to left.

The distance each character would go at a turn is determined by the number on the die after it is rolled, that number can be represented as a random number from 1 to 6. The compiler does not recognize the boxes but only coordinates of the interface, therefore, the distance a character will go is modelled according to the coordinates of the boxes. Since each box represents 60 pixels, the distance (in pixels) that a character will go per roll is given by;

$$distance = 60 * die\ number \tag{1}$$

Therefore, the maximum distance a player can go at once is 360 pixels (6 boxes) and the minimum is 60 pixels (1 box).

To move this distance on the board, the distance is added to the current position of the character on the x-axis. At the initial state, all characters start at zero at both the x- and y-axis. The system also needs to recognize when it has reached the last box on that row. For the rows with odd numbers, that end is located at 540 pixels on the x-axis. Also, the system needs to know if it should move from left to right or from right to left depending on its position on the y-axis. All these can be represented by:

$$x = \begin{cases} x + distance, & y = 0\ OR\ y = 120\ OR \\ & y = 240 \\ & OR\ y = 360\ OR\ y = 480 \\ x - distance, & otherwise \end{cases} \tag{2}$$

The equation shows the ideal next location of the character after the die has been rolled and the distance calculated. The distance is added to the current x-position of the character if the character is on the 1st, 3rd, 5th, 7th, 9th roll, all located on 0, 120, 240, 360, and 480 pixels on the y-axis. The distance is subtracted from the current x-position when the character in on other rows.

The equation only shows how the characters should move on the x-axis, when the movement is only on one row and does not extend to another. Therefore there is need to always test for when there is need to go over another row. This can be simply done by comparing x with 540 on the odd-numbered rows and with 0 on the even-numbered rows. Recall, the last box on the rows with odd numbers is located on point 540 but it is 0 on rows with even numbers.

Therefore, the following algorithm follows

Start
Step 1: If y=0 OR y=120 OR y=240 OR y=360 OR y=480 AND x > 540 THEN

Step 1.2: Move character to point 540 on the x-axis

Step 1.3: Move character to point (y + 60) on the y-axis

Step 1.4: Calculate distance left:

$distance\ left = x - 600$

Step 1.5: Move to point (540 – distance left) on the x-axis

Step 2: Else if y=60 OR y=180 OR y=300 OR y=420 OR y=540 AND x < 0 THEN

Step 2.1: Move character to point 0 on the x-axis

Step 2.2: Move character to point (y + 60) on the y-axis

Step 2.3: Move to point a on the x-axis given by:

$$x = (distance - (x + distance + 60))$$

End

The winner of the game is the first person to reach the 100th box, located on point (0, 540). Therefore, a test is always carried out for when a character reaches this point. At which stage such player is declared winner.

4. System Implementation

The software is implemented using Java programming language with JavaFX and FXML as the frameworks and is styled using Cascading Style Sheet (CSS). JavaFX Animation and JavaFX Collections were some of the inbuilt libraries used while JFeonix and MySQL Connector external libraries were imported into the code. JFeonix library is a style library used to design the interface of the main game window while MySQL Connector was used because of the need to connect the program to an active database. This implies that the database used was MySQL with Wamp server as the host server. The database was also created using WAMP server. The text editor used for the coding and packaging was InteliJ IDEA Community Edition 2016.2.

The implementation of this game is in sections according to the scenes needed in the game. In total, seven scenes make up the entire game including the Menu scene, the settings scene and the main game scene. Some of the scenes, their functions and their screenshots are discussed below.

4.1. Menu Scene

The menu scene (Figure 5) comes up when the game is launched. It is made up of the title of the game, description of the game and options available to the user.

There are five options represented in the form of buttons which are Play Game, Check High Scores, Settings, About the Game and Quit. To play the game, the user clicks Play Game and it takes the user to the scene where they would choose the number of players. Check high scores opens the high score scene. To toggle between sound on and sound off, the user clicks on settings. The user clicks on quit to end the game, but a confirmation pop-up comes up first. A background is also added to this scene and the other scenes using CSS for aesthetics.
When the user clicks on Play Game, a scene comes up asking the user the select the number of players, then another scene comes up where the players enter their names and choose the character they want. The game scene then comes up where the players can begin the game.

Figure 5. Menu Scene of the Snakes and Ladders Game

4.2. Game Scene

The game scene as shown in Figure 7 was designed and implemented in FXML, a combination of JavaFX and eXtensible Mark-up Language (XML). The syntax of this hybrid of languages is somewhat different from the ordinary Java syntax as it also carries elements of XML syntax. Although a Controller Class written in pure Java was attached to the code to manage it.
FXML only controls the interface and elements of the system, while the Controller class controls the activities and operation of those elements. This scene still remains in the same Stage (window) as the other scenes in this application.
The game has a scoring system whereby the players are awarded scores based on their moves. The first player to reach the 100th box and therefore wins has the lowest score. The players move on the board clicking on the die. A random number from 1 to 6 is then generated.

The main purpose of the game is to simulate a scenario where the player behaved in either a good or bad manner morally speaking. In the game, this is done as a popup (Figure 6) when the player falls either on the foot of a ladder on at the mouth of a snake.

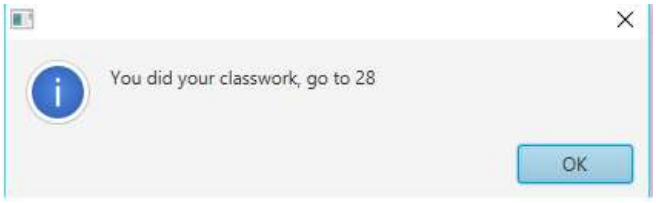

Figure 6. Popup Menu when a player falls on the foot of a ladder (Good Behaviour)

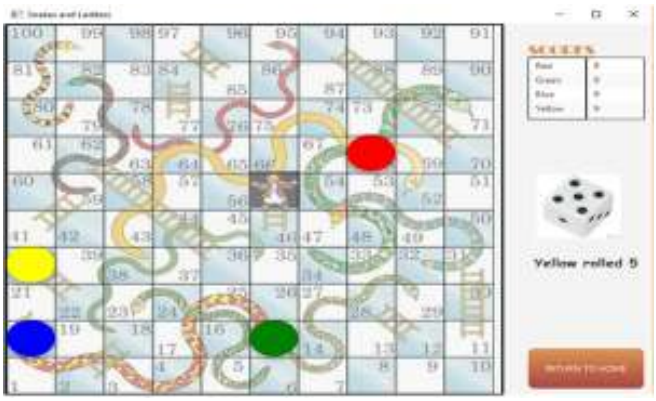

Figure 7. Screenshot of the game in progress

5. Result

About twenty (20) children of ages six (6) and seven (7), with the permission of their parents, were casually asked fifteen (15) questions relating to moral values and societal rules and it was found that about seventy percent (70%) of them did not know or were not willing to follow at least fifty percent (50%) of these rules.

They were then asked to play the game several times in turns (four children at a time). At the end of the day, they were asked the same questions and they all knew what behaviours were bad and which ones were acceptable. And also, less than 40% percent of them were still unwilling to follow at least 50% of these rules.

The children were observed while playing the game and were found to shockingly understand how bad some behaviour could be when they went down the length of the snake and therefore lost their place ahead of the other players or the ground they were gaining on those in front. Also, it was found that they happily appreciated the fact that doing something good was beneficial for them.

6. Conclusion

Generally speaking, there have been some complaints about the degrading nature of morals of youths in this generation and it is believed to have stemmed from upbringing in most situations. Parents no longer have time for their children, children have tendency not to take to their parents' instructions. Most times, these children

disregard their parents because they probably do not fully understand the impact of their behaviours and decisions.

If something is done to, perhaps subconsciously, help them at a very young age understand the impact of their behaviour such as this simulation of the snakes and ladders game, which was inspired by ancient *Leela*, then, there is a chance to actually steer some of them away from a future riddled with bad decisions and immorality to a life well-lived.

It is a basic assumption with parents especially Africans that kids gain nothing from playing games. However, this has been proved to be otherwise. Parents therefore should be encouraged on every available platform to allow their kids spend some time in a relaxed environment to play games, especially those that could boost moral education.

There are also games with added purpose of educating children, such as this game, Snakes and Ladders. These kind of games should be encouraged as it helps develop them into responsible men in the future.

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