KineSpell2
Acceptability Test of Wii Remote as a Controller of an Educational Game

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Abstract— KineSpell2, a digital game-based learning application, is developed to maximise the learning of spelling. It provides an enjoyable environment that motivates students to learn. The purpose of this research is to establish the acceptability of the Wii Remote as a wireless controller of KineSpell2 through the Controller's Learnability, User Satisfaction and Ease of Use. The acceptability test result suggests that using the Wii Remote as a game controller in an educational context can provide an enjoyable environment with a high acceptability rating.

Keywords—VAK learning styles; Educational game; Wii Remote; Spelling; Game controller

I. INTRODUCTION

According to a paper written by Berthouze, Kim and Patel [1], a new generation of games are beginning to offer control devices that allow for a more natural type of interaction. One example given is Guitar Hero, introduced by Red Octane for the PlayStation. It comes with a guitar-shaped device with tilt-in sensors that require guitar-player-like movements for controlling the game. The aim of these devices is to allow the player to control the game through natural movements.

Since the birth of Digital Game-Based Learning (DGBL), academia uses every possible high technology gadget and tool, such as common and popular game controllers, to address 21st century learners. DGBL provides motivation for learning subjects and contents that are difficult to teach or train. Games can engage players in learning that is specifically applicable to schooling, and teachers can leverage such games without disrupting the worlds of either play or school [2]. In his book, Marc Pesky stated that games are a form of fun that provide enjoyment and pleasure, and at the same time a form of play that gives intense and passionate involvement, have goals that give motivation, and have outcomes and feedback that offer learning [3]. It can provide an environment where students can explore, manipulate and learn things on their own.

Spelling is an important communication skill that, like other basic skills, is best learned at a young age. But according to Grace Fernald, the methods used by the schools may prevent many children from learning how to spell [4]. Traditionally, most children write a word many times in succession to memorise it, which is not good practice. This results in poor attention due to lack of interest in the content, loss of meaning due to the hypnotic effect of monotonous repetition and an introduction of errors as the content loses its meaning [4].

As modelled by Rita Dunn and Kenneth Dunn, known as the Dunn and Dunn Learning-Styles Model [5], there are different learning styles that individuals uniquely have: the Visual, Auditory and Kinesthetic learning styles. Visual learners learn through what they see with their own eyes, auditory learners acquire information through what they hear and kinesthetic learners absorb information through movement and action.

II. KINESPELL2

KineSpell is a learner-centric digital game-based application that provides an alternative way of learning spelling for students aged 8-9. It is designed to accommodate learners using the VAK (Visual-Auditory-Kinesthetic) learning styles. This application utilises Sun Microsystem's Small Programmable Object Technology, or SunSPOT, as a game controller. It uses Java 2D API to ensure the quality of the graphics used in the game. Attractive graphics and animation were applied to the game to keep the user's interest. KineSpell consists of Game Application Components such as the Game Interface, Game Core, Assessment, Dictionary Manager, and the Learning Components (VAK). The main engine of the game uses the Game Core and Game Manager programs to handle the main game loop and the transition between states after each state of the game finishes execution. KineSpell provides an assessment, which is based on the assessment cycle widely used in e-learning, to allow users to track the development of their learning [6]. Figure 1 shows the assessment cycle used by KineSpell.

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KineSpell2, an improvement of KineSpell, adopted the latter's game structure, but added and changed some of the features and components. Some of the existing components are the Player Manager, Dictionary Manager, Assessment Manager and the Game Setup. A Controller Component was
then added to the game. This newly created component makes learning more student-centred. The Player Manager handles the creation of new players, editing of profiles and switching between players. Here, students can be creative when choosing any name to be their display name. The Dictionary Manager handles the addition and deletion of categories and words. Teachers can add words and record audio files that are applicable to the specific level of the students. The Assessment Manager helps the students follow their own improvements. It also helps the teachers and/or parents track the student's development in learning spelling. It shows the date the assessment was taken, the category and the words. The Assessment Manager also indicates the total score, the time it took the child to spell a word, the total time played and the number of times the student used a hint. In the Game Setup, students can adjust the resolution of the game, the colour quality and the volume of the sound. They can also choose the spelling aids (visual and/or auditory) that they want to be enabled while they are playing. In the game, students have the freedom to choose a game world or background. The word will be presented to them depending on the spelling aid that they activated. The objective of the game is to pop the animated bubbles containing letters of the word they have to spell by controlling the dragonfly (cursor). For each word that they have to spell, they are given 3 hints and 3 game lives. They may also, depending on the activated spelling aid, hear the proper pronunciation or see the correct spelling of the word. Figure 2 shows the state machine of Kinespell2 that was adapted from its predecessor, while Figure 3 shows the Kinespell2 game in action.

A. Software Architecture

Kinespell2 adopted the original Software Architecture of KineSpell shown in Figure 4. Major developments of Kinespell2 included the addition of an auditory component and the use of the Wii Remote as game controller.

1) Auditory Component

KineSpell was originally designed to cater for VAK learning styles but with a greater focus on kinesthetic learners through the use of SunSPOTs. KineSpell2 reinforced the auditory component of the game by adding an audio recording feature in the Dictionary Manager. In the previous version of KineSpell, the words in the database are pre-recorded using other applications. Now, with the new Auditory Component of the game, the word can be recorded and saved in the database without using or opening other applications. With this, teachers can now apply phonics-based teaching methods and record the proper pronunciation of the words. The auditory component will provide audio playback during the game and the recorded file will serve as an auditory clue.

2) Wii Remote Component

Wii Remote, commonly called “WiiMote”, is a game controller developed and introduced by Nintendo. It is the primary controller of Nintendo’s Wii Console. It is one of the controller devices that allow a more natural type of interaction. Because of its popularity as a controller, it has been modified in many ways to suit the needs of the players. Also, there have been expansions and accessories available for Wii Remote such as the Nunchuk, the Classic Controller, Wii Zapper, Wii Wheel, and the Wii MotionPlus. Nunchuk was the first controller attachment for the Wii Remote. It has similar motion-sensing technology to the Wii Remote. The Classic Controller is an expansion of the Wii Remote. It is used primarily as a wireless transmitter. It connects to the bottom of the Wii Remote controller to allow wireless connectivity with the Wii Console. The Wii Zapper is a gun shell accessory for the Wii Remote. The shell receives both the Wii Remote and the Nunchuk. The Wii Wheel is another Wii Remote accessory, which gives a fun and comfortable way to play driving and racing games on the Wii video game system [7].

It was assumed that the target users would be more comfortable using a more popular game controller when playing the game. Since the Wii Remote or Wii Remote has established a firm association with games and is already a popular controller, using it in an educational game may receive good feedback from the target users.
3) Modification of Other Component

As suggested in the evaluation of the previous version of KineSpell, the teacher may add an extra letter to the jumbled letters of the word the player has to spell. The extra letter can be added by adding or editing a word in the Dictionary Manager. In the attempt to spell the word correctly, the child is practicing his phonetic skills and is critically thinking about choosing what letters to include in his word. As an example, the word FORTIFIED can be misspelled as portified, fortipied or portipied. With an extra letter P, the child will need to consider whether the correct spelling uses P and will try to associate the spelling of the word to its pronunciation, and thus will arrive at the correct spelling.

B. Controller Technology

The game is a Java application that runs on both Windows XP and Vista. It makes use of SunSPOTs and the Wii Remote as game controllers. It is designed to detect the Tilt Motion (up, down, left or right) of the controller. The game was built on a separate package for each type of controller.

1) SunSPOT

There are two kinds of applications in SunSPOT, the SunSPOT Application and the SunSPOT Host Application. SunSPOT Application uses CLDC 1.1 and IMP 1.0 application models and runs on free-range SunSPOTs while the SunSPOT Host Application runs on a SPOT that is configured as a base station connected to the host machine (computer) that interacts with the target (SunSPOT). The Host application is a J2SE program, while the Target application is a squawk java program [8]. KineSpell is a SunSPOT application that is actually a MIDlet implementation. KineSpell2’s SunSPOT component, like every SunSPOT application, has the following components; Boot loader that handles USB connection, launching of applications and interaction with ant scripts; Configuration Page that controls the parameters that condition the operation of the boot loader; Bootstrap Suite that contains the standard JAVA ME classes; Library Suite that contains the SunSPOT-specific library classes; and Squawk VM, SunSPOT’s Virtual Machine, that uses isotopes to enable multiple applications to run on a single virtual machine [8].

Figure 5 is the SunSPOT Development Kit (SDK). It is composed of a base station and the two remote SPOTs. The Base Station is attached to the computer via a USB connector. It uses a 2.4GHz radio to communicate with the remote SunSPOTs that are acting as controllers. The SDK uses the GCF (Generic Connection Framework) to provide radio communication between SPOTs, routed via multiple hops if necessary, using a choice of two protocols. The Radiosteam protocol, a socket-like peer-to-peer protocol, provides reliable, buffered, stream-based communication between the devices. The Radiogram, client-server, protocol provides datagram-based communication between two devices [8].

The two remote SunSPOTs are executing the “Over the Air”, or OTA, Command Server and are connected to the basestation with a specific remote SunSPOT ID. The remote SunSPOTs are programmed to send specific movements (Tilts) to the basestation [8]. KineSpell2’s base station runs in a dedicated mode, so it can only be used by the application.

```java
EDemoBoard db = EDemoBoard.getInstance();
IAccelerometer3D acc = db.getAccelerometer();
acc.setRange(0); // 29
IScalarInput xAccel = acc.getVal();
int xa = xAccel.getValue();
```

Figure 6 SunSPOT Accelerometer Code Snippets

SunSPOT has a built-in three-axes accelerometer and uses a ST-Micro LIS3L02 component. The line of codes in Figure 6 sets the accelerometer. The last two lines of code get the x-position of the remote SunSPOT and change the position-value whenever the SPOTs are tilted.

2) Wii Remote

The KineSpell2 game utilises Bluetooth technology as a medium to connect the Wii Remote to the computer. The device is located on a single chip, Broadcom BCM2042 Bluetooth chip, and it contains multiple peripherals that provide data to it, as well as an expansion port for external add-ons. The chip fully supports the Bluetooth 2.0 specification and the entire protocol stack for Bluetooth devices [9]. Below is a picture of a Wii Remote Controller.

Wii Remote uses ADXL 330, a three-axes accelerometer-sensing device, which is manufactured by Analog Devices. It measures acceleration along three axes with a range of ±3g with a sensitivity accuracy of 10% [11]. The Wii Remote also contains an IR Camera made by PixArt, which is located in the front of the controller. It can track up to four IR-hotspots. Information regarding IR-hotspots, their size and location, can be sent back to the host. Although Nintendo has created a specific sensor bar that
emits infrared lights to use with the camera, anything emitting infrared lights, such as candles, can be used [12]. The Wii Remote also provides audio and rumble functionality.

The WiiUseJ API was also used in the application. It can be used in Windows and Linux platforms. It contains different methods for different event types such as ButtonEvent, IREvent, MotionSensingEvent, ExpansionEvent, StatusEvent, DisconnectionEvent, NunchukInsertedEvent and NunchukRemovedEvent [13].

```java
WiiRemote[] wiiRemote = WiiUseJManager.getWiiRemotes(1, true);
WiiRemote wiiRemote = wiiRemote[1];
WiiRemote activateMotionSensing();
WiiRemoteAccelerometerHouse mouse = new WiiRemoteAccelerometerHouse.DefaultFiltHbouse(wiiRemote);
mouse.enableHouse();
```

Figure 8. Wii Remote Accelerometer Code Snippets

As shown in Figure 8, the first line limits the connection to a single Wii Remote. It returns an array of connected Wii Remotes in the 2nd line. The third line of the code activates the MotionSensing. Once activated, the Wii Remote will be able to detect motions. The last two lines set the motion of the Wii Remote to tilt motion only. The enableMouse() method makes the Wii Remote act as a mouse.

C. Acceptability Test Methodology

The main objective of the test is to determine the acceptability rating of KineSpell2 using a Wii Remote. It is evaluated over the following main criteria: Controller's Learnability, User Satisfaction and Controller's Ease of Use. Learnability is the user's ability to operate the system to some defined level of competence after a predetermined period of time. Satisfaction refers to the user's perceptions, feelings and opinions [14], while ease of use includes how comfortably and how easily the user can control the remote.

Each student is given a maximum of 20 minutes to explore the game using the Wii Remote. Within that time, they must be able to create a player account, be able to choose a game world or background, select the category entitled ‘testing’ and be able to spell 3 words. The words in the ‘testing’ category are chosen by their language teacher and are relatively easy for their age and grade level. They are observed and timed. The moment that they are able to expertly navigate the dragonfly around the screen will mark Learnability. Learnability, or familiarisation time, is subjective since there is no definite measure of their ability to operate the remote; it is purely based on observation. The researchers served as observers during the familiarisation period.

Active Game Play follows the familiarisation period, in which they take turns in playing the game and players must wait for their turn. There are seven words to be spelled using the Wii Remote as the controller. The words, selected by their language teacher, are appropriate to their age and grade level. This time, though the game time is being recorded by the application and will be indicated in the assessment, there is no time limit. Their turn will end as soon as they finish spelling all the seven words.

Evaluation follows active game play. Questions pertaining to the controller's acceptability will be answered on the evaluation forms. There are questions regarding the controller's Ease of Use and questions to determine Satisfaction. There is also a portion for observations about what they think of the game (comments and suggestions). The evaluation uses the Likert-type scale for Levels of Agreement, 1 (strongly disagree) being the lowest and 5 (strongly agree) being the highest. Completed evaluation forms are then gathered and conclusions based on the observations and evaluation results are drawn.

III. DISCUSSION

A. Wii Remote Components Development

It takes 1 week to learn the SDK of the Wii Remote and 1 week to develop the Wii Remote Components of the game. Unlike the SunSPOTs components that were developed by the developers of KineSpell, no specific program is created and loaded to the Wii Remote. And, unlike the SunSPOTs component of the game where two controllers are used, the developers of KineSpell2 designed the game to accept and connect just one Wii Remote since it is not necessary to have 2 remotes to control the game. The SunSPOTs component was designed to accept connection from one or two SPOTs only. It was designed in that way for it was intended to target learners that are more suitable for kinesthetic learning. The designer considered the balance of the left and right upper extremities.

The original plan for the Wii Remote Components was to use the IR (Infrared) sensor bar in order to have smooth control of the dragonfly. But since it was not available, the Bluetooth stack was used. Wii Remote's accelerometer was then used to track the tilt motions of the remote.

B. Acceptability Test Results

The testing involved a total of 22 Grade 2 (age 8-9) students. Sixteen students came from Roosevelt College, Marikina and six came from the University of the Philippines Integrated School. All 22 students are computer literate and are computer or video game players. Out of 22 students, 15 know what a Wii Remote is, 12 students said that they have seen the actual remote, and 7 out of 22 have experienced using the Wii Remote to play games.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Average Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of Use</td>
<td>3.53</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>4.67</td>
</tr>
<tr>
<td>Familiarisation Time</td>
<td>6.52 minutes</td>
</tr>
</tbody>
</table>

The evaluation of KineSpell2 using the Wii Remote is shown in Table 1. It received a good rating for Ease of Use and a high rating for Satisfaction. The testers found the tilt motion of the Wii Remote a little difficult to handle and it is observed that they all use two hands to hold the remote. It takes them an average of 6.52 minutes to be fully familiar with the movement of the remote. The fastest finished in 4.37 minutes and the slowest took 7.09 minutes to familiarise himself with the remote and the game.
Out of the 22 students, 18 liked the Wii Remote as a controller of KineSpell2 but they said that it would be better if was easier to control the dragonfly with the remote. All of them thought that the game was exciting and challenging and all of them enjoyed playing the game. They even asked if KineSpell was already out in the market or if it was downloadable.

It was observed that the students were excited to play KineSpell2. The fact that they were undertaking a spelling exercise using the game did not change their positive attitude. Giggles of excitement and comments were received when they were told that they were to use the Wii Remote as the controller. During the game, the majority of them would stand and move their body as they moved the controller. They shouted with joy and they jumped whenever they got the correct answer, but there was also a sound of disappointment whenever they failed to spell the word. However, it encouraged them more to try again and spell the word correctly. Some of them would repeat the word they had to spell and would ask someone if they pronounced it correctly. Meanwhile, their classmates who were watching during the familiarisation period were cheering. All of them wanted to keep on playing the game and were looking forward for their turn to play.

IV. CONCLUSIONS

The test result shows a good overall acceptability rating of KineSpell2 using the Wii Remote. It can be assumed that the implementation of the tilt motion of the Wii Remote may be the cause of its 3.53 rating for Ease of Use. Implementation of IR Tracking might improve the Wii Remote’s Acceptability test with KineSpell2.

Despite the limited number of testers, the test results suggest that a popular game controller, such as Wii Remote, may also be used as a controller for an educational game. It also suggests that students nowadays will really enjoy learning if the environment and the tools they are using fits what their generation is into.

V. RECOMMENDATIONS

The researchers recommend that the experts in the area of language/spelling, game development and other stakeholders evaluate the game as an educational tool. Testing to determine the significant impact of the game to the learner’s learning style (VAK) is also an important aspect of improving the game. Also, developing an application that uses different assessment methods, such as choosing the correct spelling out a number of choices and spelling the word without letters to choose from, will further enhance the students’ learning on spelling.

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