

AFRICAN CONTEXTUAL COGNITIVE EXERCISE FOR DEMENTED PATIENTS: THE GAME À YÒQLÒPÒN

^{1,5}Richard O. Oyeleke, ²Tobore V. Igbe, ³Justice O. Emuoyibofarhe, ⁴Femi O. Ololade,
⁵Agnes Akinwale, and ⁶Halleluyah O. Aworinde

¹Department of Computer Sciences, University of Lagos, Akoka.

²Department of Computer Science, Federal University of Technology Akure.

³Department of Computer Science & Engineering, Ladoke Akintola University of Technology,
Ogbomoso

^{4,6}Department of Computer Science & Information Technology, Bowen University Iwo

⁵Department of Computer Science, Yaba College of Technology, Yaba.

Correspondence: {oyeleke.femi, tobore2ng, eojustice, femialamu}@gmail.com

Abstract:

Dementia is one major disease associated with ageing, which causes the brain to malfunction. Often its symptoms include loss of memory, confusion, and loss of speech to mention a few. One of the popular forms of dementia is the Alzheimer's disease. It is a disease of the aged and the number of sufferers continues to skyrocket as the population ages. Sufferers of dementia are found in all parts of the world, although more prevalent in the Europe, America and Asia because they have greater ageing population.

However, According to the United Nations (2011), Africa's population is ageing swiftly at a rate of 2.27% than other parts of the world. More so, United Nations (2007) reported: over 60 years of age accounted for 5.1% of the African population and it is expected that this figure go double or more to 10.4% by 2050. Despite these projections of the number of sufferers in years to come, cases of dementia can be reduced drastically through preventive interventions, improved treatments and care strategies, as well as disease-modifying interventions. Generally, prescription of drugs to patients has been the most common way of managing and treating dementia, yet their efficacies are not satisfactory, especially with their associated side effects.

Recently, medical experts have found that cognitive exercise like Sudoku has been proven to help sufferers of dementia to exercise their brain to stimulate function. Cognitive rehabilitation activities like solving Sudoku puzzles are used for treatment of demented people and also recommended for non-patient for prevention. With health institutions in Africa, Nigeria especially still struggling to cope with bed spaces for patients and low doctor to patient ratio, we therefore propose a preventive intervention and memory care strategy for the management of dementia disease and to help improve patients' quality of life. Therefore, this work proposes the implementation of a mobile game version of a popular board game known as "Ayo" or "Ayo Olopon" played in most African countries

Keywords: Dementia, Brain Exercise, Mobile game, À yò Olopon

1. INTRODUCTION

Dementia is a health condition which causes the brain to function abnormally. More often, it is a disease that affects the ageing population but with no exemption to the young demography (Ed. Brenda Patoine, 2004). Sufferers of dementia, especially Alzheimer's (most common type of dementia) are found in all parts of the world (Yusuf et al. 2011). Alzheimer's Disease International [ADI], in year 2005, estimated 24.3 million sufferers of dementia in 2001, with 60% representing sufferers living in countries classified as low- and middle-income (LMIC), and 4.6 million new sufferers of dementia were predicted each year, with numbers affected nearly doubling every 20 years to reach 81.1 million by 2040 (Prince et al. 2013). Similarly, in 2008, ADI estimated 30 million sufferers of dementia worldwide, with an annual new sufferer of about 4.6 million (one new case in every 7 seconds) (ADI 2008). Further, in 2010, it was also estimated that 35.6 million people lived with dementia worldwide, with numbers expected to almost double every 20 years, to 65.7 million in 2030 and 115.4 million in 2050. In 2010, 58% accounted for sufferers who lived in countries with low or middle incomes, with this proportion anticipated to rise to 63% in 2030 and 71% in 2050 respectively (Prince et al. 2013).

Although, incidence and prevalence of dementia is very low in developing nations especially on African continent as compared to the developed nations, but with the growing population of the aged in developing nations, it is not unlikely that the number of demented people will be on the increase. It is projected that by the year 2020, developing nations will experience a 200% increase in the population of the aged as compared to a 68% increase in developed countries (ADI 2008). Despite these projections of the number of sufferers in years to come, cases of dementia can be reduced drastically through preventive interventions, improved treatments and care strategies, as well as disease-modifying interventions.

With new research from the medical professionals, it is believed that mental exercise will greatly help in preventing dementia. Although there exist a group of drugs recommended for the treatment of dementia, however, newer researches have shown that mental exercises prove more effective than drugs. The game called "Sudoku" has been recommended by the health professionals. No doubt Sudoku is logic-based puzzle and offers memory exercise as identified by the medical professionals. It is in the light of this that we have identified "Ayo" or "Ayo Olopon" game as a potential rehabber for sufferers of dementia in Africa rather than Sudoku. Ayo is the most popular African game not just reflecting the cultural values of the people but also helps subject the brain to rigorous exercise. Since culture is a way of life and people tend to embrace and protect their cultural values, we therefore see "Ayo", a potential rehabber for demented people of Africa.

2. AFRICA'S AGEING DEMOGRAPHY

Although, ageing is a global phenomenon, yet, it poses a great threat to developing countries. Hence, this calls for urgent intervention: requiring significant funds be earmarked for improving healthcare sectors of developing nations to ensure demography of healthy aged (Ayernor, 2012). According to the United Nations (2011), Africa's population is ageing swiftly at a rate of 2.27% than other parts of the world. More so, United Nations (2007) reported: over 60 years of age accounted for 5.1% of the African population and it is expected that this figure go double or more to 10.4% by 2050. This begins to raise more concern for African continent as most of its countries are classified as developing nations (United

Nations 2009). This trend of growing ageing population of Africa will continue for foreseeable future, with the Northern and Southern Africa expected to have the fastest rate of growth of the ageing population (ed. Maharaj, 2013).

According to Ajomale (2007), Nigeria has the largest population in Africa, boasting a population of 140 million people. It is projected that the population of Nigerians who aged 60 and above will account for 6% of the total population. More so, the projection for West Africa by 2025 and 2050 are 5.5% and 9.0% of the entire population respectively. In year 2012, the population of the number South Africans who aged 65 and above constitute 6.54% of the entire population, and a projection of 8.45% and 12.02% for 2025 and 2050 respectively (Home instead web). Ghana is no exception to the growing population of the aged. Results from its 2010 census, the population of those who aged 60 and above increased to 1,643,978 which translates to a 6.7% of the total population (ghanaweb.com).

With growing concern for the ageing population globally, it is believed that the African countries are miles apart from being capable of managing the growing population of the aged. According to The African Development Bank, "Aging is highly connected with long-term physical and mental disability, as well as long-term chronic conditions." The bank's chief economist, Professor Mthuli Ncube also reiterated that: "Africa is not well prepared to care for its aging population at the moment, but it should brace up to combat this phenomenon (DeCapua, 2011).

3. DEMENTIA: THE PREDATOR

A major risk factor of dementia is age, and this has seen number of demented people rise very quickly. Generally, dementia is uncommon in persons whose age is less than 65, although, sometimes, early appearance of dementia is seen with persons whose ages fall between 40 and 50 years. In such cases, it is usually traceable to genetic risk factors like: defect on chromosome 14 and Down's syndrome (Stephan and Brayne 2008). Globally, the most common estimates of dementia has been the age-related incidence with a predicted exponential rise in dementia with age (Stephan and Brayne 2008). A prevalence of 2.29% for dementia and 1.41% for Alzheimer's disease was reported among the Yoruba ethnic group in Nigeria (Hendrie et al. 1995), the Republic of Benin recorded a prevalence of 2.6% for dementia (Guerchet et al., 2009), and in Egypt, a prevalence of 4.5% was reported among the Arabs aged over 60 years (Farraq et al. 1998).

The word "Dementia" is an all-encompassing name for health challenges with the functioning of the brain. This brain malfunctioning may include but not limited to: loss of memory, confusion, loss of problem solving skill and other form of impairments (Home Instead Senior Care, 2012). One of the popular forms of dementia is the Alzheimer's disease. It is a disease of the aged and the number of sufferers continues to skyrocket as the population ages. Alzheimer's disease symptoms usually include difficulties with speech, problem with usual activities, like strolling. More so, there are instances of changes in mood of the sufferers. As this disease continues to thrive, health conditions worsen affecting long-term memory and behavioural changes such as aggression, anxiety, delusions, and verbal outbursts may occur. Sometimes sufferers tend to compromise to carry out daily tasks, such as dressing or bathing (Ed. Brenda Patoine, 2004).

4. REHABBER FOR DEMENTIA: MEDICATION OR BRAIN EXERCISE?

Drugs have been the most common medication recommended for the treatment of dementia in recent years, this group of drugs are oftentimes referred to as “dementia slowing” or “memory enhancing” medications. The commonest of them known as cholinesterase inhibitors. Although these drugs do not halt the underlying progress of dementia, but they often support better thinking and memory. It is a general believe that with time, the drugs will become less effectiveness. More so, side effects from taking these medications are modest which may include: stomach or digestive (GI) problems, vivid dreams, and agitation. According to David Troxel, a renowned expert in Alzheimer’s disease and memory care, he noted that the “treatment” for dementia is socialization, keeping the person active with exercise, music and creative activities. “Engaging the person in life as much as possible fights depression and keeps him or her operating at their very best.”(Home Instead Senior Care, 2012).

However, with unrelenting effort of the medical professionals in curbing the incidence and prevalence of dementia, more researches have been conducted and interestingly, results from these researches have come to displace the conventional method of recommending drugs as rehabber for dementia.

According to (Krans 2013), considering the fact that the new St. Michael’s study indicates that sufferers of mild cognitive impairment do not benefit from drug-based therapies, experts say certain lifestyle choices may be able to slow cognitive decline. Quoting a study conducted earlier this year in the *Journal of Aging Research*, it was found that physical exercise is a promising non-pharmaceutical way to avoid age-related cognitive decline and neurodegenerative diseases. Hartley, and other medical experts, recommends brain exercises, such as crossword puzzles and Sudoku, as good ways to stay mentally and emotionally engaged to prevent decline.

More so, in a related article, cognitive exercise like Sudoku has been proven to help sufferers of dementia to exercise their brain to stimulate function. It works well with other activities such solving math problems or arithmetic as well as reading activities that tests their comprehension skills and ability to concentrate. However, although cognitive rehabilitation activities like solving Sudoku puzzles are used for treatment of demented people, it is medically wise and advisable that non-sufferers of cognitive impairments employ these techniques to help engage their mind and keep it active (sudoku professor.com).

5. POTENTIAL AFRICAN REHABBER FOR DEMENTIA: À YÒQLOPQON

One of the brain exercises that have been recommended by the medical expert for rehabilitation of sufferers of dementia is the game called Sudoku. Although became popular through the British media but was originally designed by Howard Garns, a freelance puzzle constructor, and first published in 1979. Thereafter, Sudoku was introduced in Japan in the paper known as “Monthly Nikolist” in April 1984 as Suuji wa dokushin ni kagiru, which means “the number must occur only once”, and later, the name was later abbreviated to Sudoku. The immense surge in popularity of Sudoku in British newspapers and internationally has led to it being dubbed in the world media in 2005 the “fastest growing puzzle in the world”[1]. Despite its huge popularity in the Europe, it is not the case in Africa. This implies that it will take some time to gain such popularity amongst the people, and more so, it would be easier for people to adopt and fancy playing games which they have grown up with especially when it portends their cultural values. According to Kreeps (1990),

in order to play a game, a player must possess two characteristics [3]: interest in the objectives of play, and sufficient intelligence to understand the consequences of possible lines of play (though not necessarily fully).

Although Soduko may have been recommended by experts especially in the Europe and Asia as therapy for dementia sufferers, yet its effectiveness on African patients may yield little results for the following reasons:

- a.) **Sudoku is not African:** Sudoku is a puzzle game which was designed by Howard Garns, and became popular in the Europe and Asia continents. It is a game of number system in which a number must only appear once in any row, column and region in the Sudoku puzzle.
- b.) **Sudoku do not share African tradition:** One important attribute of anyone who plays a game is their interest in the objectives of the play. If a game shares a players tradition or belief system, he would love to play the game.
- c.) **Sudoku is not popular in Africa:** If a game is not popular amongst people, the percentage of people who would know how to play the game will be very low compared to one which is very popular. More so, would be player would find it difficult to learn how to play the game when recommended.

It is in the light of this, that we have identified *Ayo*, a popular board game played across African countries, as potential rehabber for demented people as the game requires concentration and good strategies from players.

Ayo, also called “*Ayo Olopon*” is the most ancient African board game played in most African countries, especially throughout West Africa. It has many versions (“*Jerin-Jerin*”, “*Ayoayo*”, “*Ayo J’odu*” e.t.c.) hence, this accounts for the variation in nomenclature across regions and countries where it is being played (Ayeni and Longe, 1987). It is popular among the Yorubas’ who live in South-Western part of Nigeria. It is a game played by two persons at a time (Akinyemi et al 2009). Aside from being a game of the elderly, many young children also learn how to play *Ayo* as it helps to hone their math skills. Generally, it is played by people of the same age group and gender, which implies that men play with men, women play with other women, and children play with their peers (O’Connell).



Figure1: Ayo Game Play Session

The Ayo board is carved from wood and with two parallel rows of six (6) hollows each. Each of these hollows contains four seeds of the plant known as *Caesalpinia crista*, giving a total of 48 seeds at the start of the game. In some cases, an additional hollow is made at both ends of the board. These additional hollows are used for storing captured seeds by each player (Akiyemi et al, 2009).

- **Objective of the Game:** The game begins with each player owning six (6) pockets on his side of the game board, with each of the six pockets containing four seeds, which sum up to a total of 24 seeds on each side of the board. At a round of game play, the players could win and withdraw from play seeds which are in groups of four (4), each group adding to him possession of a pocket for the next round. At the end of the game round, a player who has increased his share of the seeds, has an increased number of pockets captured, giving him an advantage over the other player. Whoever wins all of the seeds during a game round has won the game.
- **Game Rules:** A Player starts by choosing a pocket from his side of the board and picks up the four seeds, placing one seed in each of the succeeding pockets in anti-clockwise direction. This step is repeated by the same player for the pocket where the last seed is placed until his play ends in an empty pocket, which marks the end of his turn. Then, the next player takes turn to play in the same manner. With exception to the final seed played, if the number of seeds in any pocket contains up to four seeds, those four seeds are won and withdrawn by the player owning the house. At the play of the final seed, three possibilities exist:
 - If the pocket was empty, the turn is ended.
 - If the pocket is contains up to four seeds, the player wins and withdraws those seeds irrespective of who owns the pocket. Again play reverts to the opponent.
 - Excepting the above, the player picks the seeds of the last pocket and continues his play. The player who wins the second to last (11th) group of four seeds also wins the last.

6. WHY GO MOBILE?

Africa has the second largest mobile subscribers in the world, and Nigeria leads the mobile market in Africa in terms of numbers of subscribers (Russell 2011). Generally, humans are nomadic by nature, hence we have implemented Ayo Olopon as a mobile game application which will be deployed on smart phones, in an attempt to making it accessible to demented patients. The variation of the Ayo Olopon we have implemented is known as “Jerin-Jerin, predominantly played by the Yoruba people who live in the South-western part of Nigeria”. This is done with the netbeans Integrated Development Environment (IDE). The game play interfaces are as shown in the figures below:

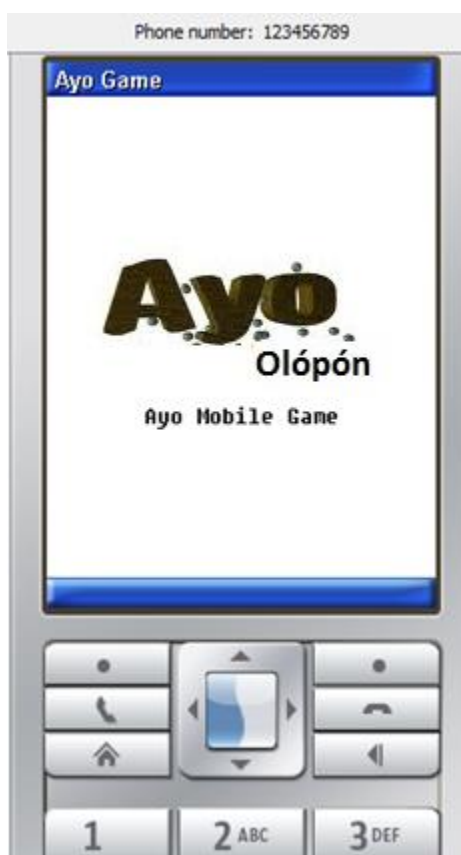


Figure 2: Mobile Ayo game start screen

Figure 2 shows the start screen or initial interface of the Ayo game. When the game app is first executed on the mobile device, it displays the game starts screen shown in figure 2 above, after about a minute; it shows the main page in Figure 3.



Figure 3: Game main menu screen

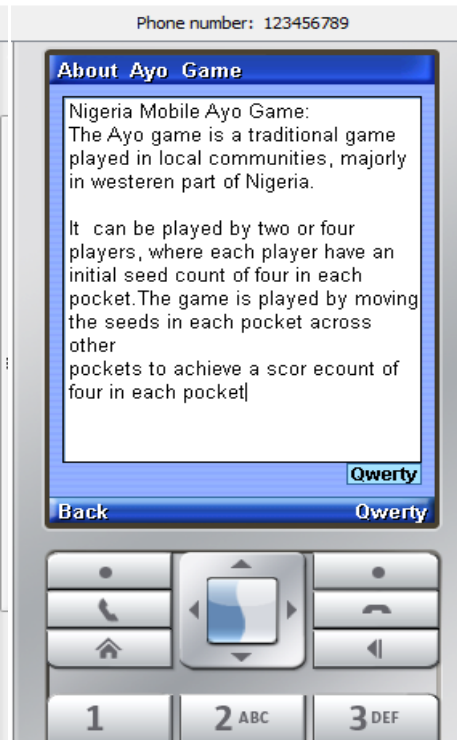


Figure 4: Interface displays game background

Figure 3 above, shows the main menu for the Ayo game, if any option from the menu is selected, it opens the required interface. The “Exit Game” menu ends the game and closes the game application.

Figure 4 above, shows the Ayo game application description screen page, it is displayed if the “About Ayo Game” menu is selected from the game main menu in Figure 3. It displays a brief historical background to the game and how it is played.

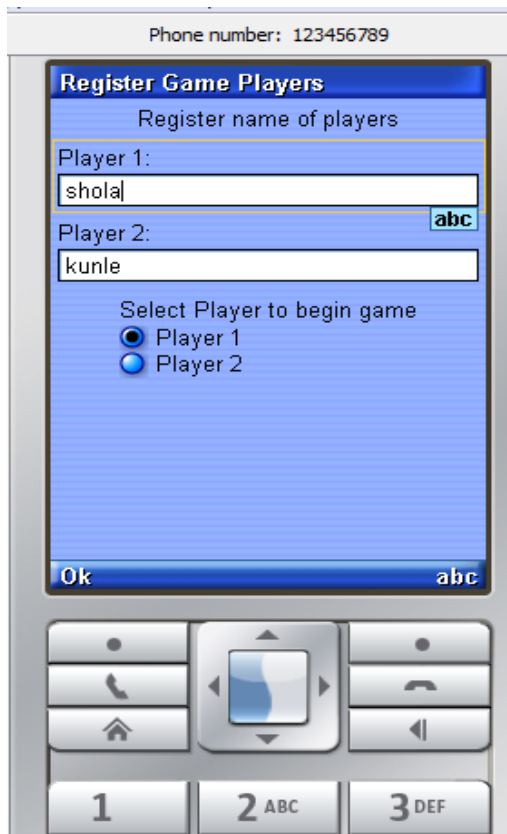


Figure 5: Players registration for a new game



Figure 6a: start game screen

When the “Start New Game” menu is selected from the main menu in Figure 3 above, a new game starts and it begins with registration of players, shown in the screen interface in Figure 5. The name of the players are registered and the player that will begin the game is also determined.

After the registration of players, the game begins with the interface shown in figure 6a the initial score (seed count) for each players is 0 and every players have 4 (four) in each pocket (pot). Figure 6b shows the screen interface as shown in Figure 6a where the player picks a pocket (pot) number containing seeds and selects “play” option as shown in figure 6c and the game distributes the seed as it would be played manually with the real game. Player picks pockets in turn to play and a complete count of 4 seeds in any player pot is accumulated for the player to form the score for the player.



Figure 6b: player picks pot number

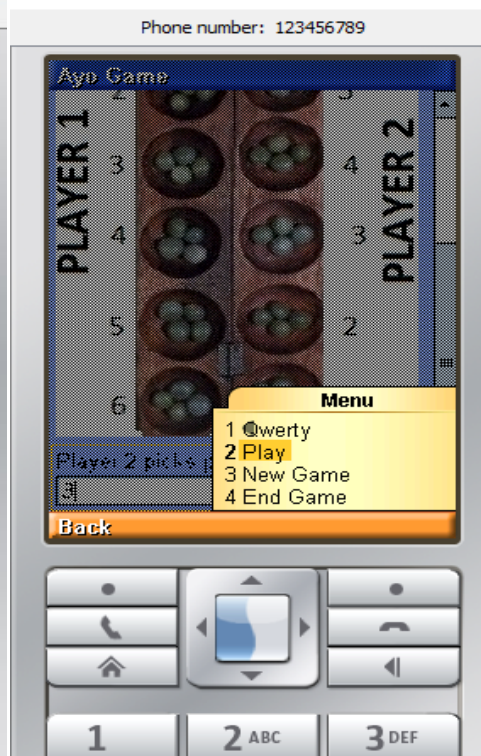


Figure 6c: Play menu selected to play game

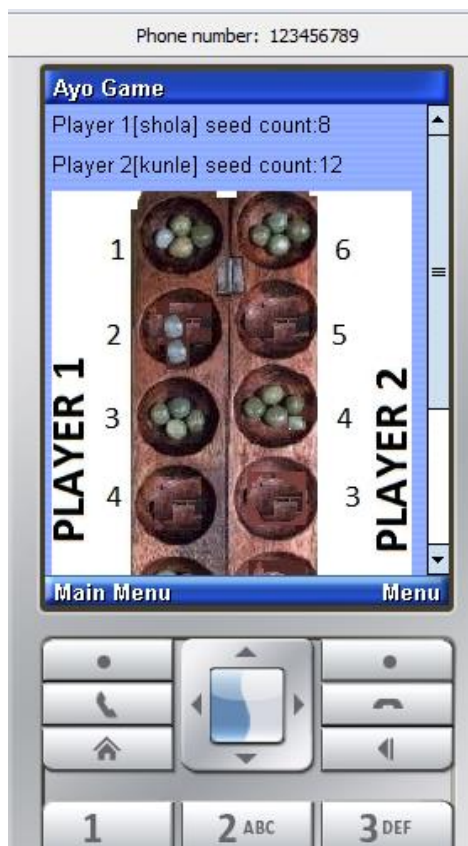


Figure 6d: Outcome of the game played



Figure 6e: Outcome of the game played

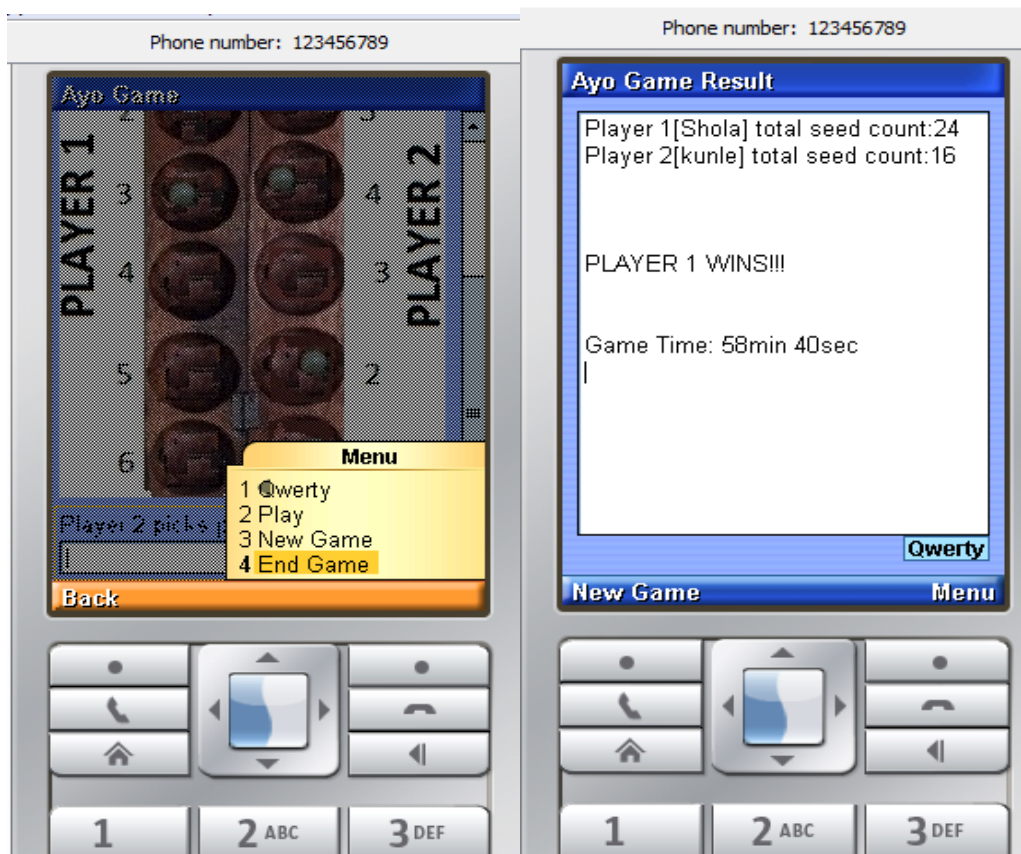


Figure 6f: Player selects **End Game** menu

Figure 6g: Final result of the game played

The game ends when any player selects “End Game” menu as shown in Figure 9a above. Further, Figure 9b above, also shows the final result of the game played between the players the game. The player with the highest seed count (or accumulated seed) is considered as the winner of the game session.

7. CONCLUSION

Medical experts in memory care have reached consensus that drugs offer temporal reversal of memory loss incidence (dementia) and even sometimes, may prove ineffective on patients. However, brain exercises: like gaming have continued to gain support from the medical professionals as potential rehabbers for demented people. Their efficacies on sufferers surpass patients being placed on drugs. Sudoku is one of the recommended games for sufferers of dementia in the Europe, America and Asia where dementia is prevalent. It is a puzzle based on logic and help demented people to recover from memory loss. Although, dementia is less prevalent in Africa, yet, with the increasing population of the aged, ageing rapidly at a rate greater than other parts of the world, Africa will in no future have its share of this disease. According to The African Development Bank, “Aging is highly connected with long-term physical and mental disability, as well as long-term chronic conditions.” More so,

it was also emphasized that: “Africa is not well prepared to care for its aging population at the moment, but it should brace up to combat this phenomenon.

It is in the light of these, that we have proposed a mobile game version of a popular board game called “Ayo” or “Ayo Olopon” played in many African countries, as a potential rehabber for demented people in Africa rather than sudoku. Since Ayo is the most ancient traditional board games played across several African countries, it implies that sufferers will once again have the feel of their culture on mobile platforms. Just like sudoku’s popularity in the Europe and Asia, Ayo is most popular board games played in Africa, hence, its acceptability by demented people and potential sufferers will not be an issue. Patients might not need learn the rules as would apply to Sudoku, since they are already familiar with it. More so, its efficacy will not be compromised as it is a game of strategy and requires concentration. These attributes we believe will help African sufferers to recover faster. Africa holds the second largest market of mobile subscribers globally, with Ayo board game coming in a Mobile App version; this will go a long way to reaching a large percentage of demented people and potential sufferers in Africa.

REFERENCES

Ageing in Ghana; is it indeed a blessing or what, Available from: <http://www.ghanaweb.com/GhanaHomePage/features/artikel.php?ID=292422>

Ayeni J.O.A. and Longe H.O.D.”Game People Play: Ayo”, Available from: <http://link.springer.com/article/10.1007/BF01769308#page-1>

D.M. Kreeps, “Game Theory and Economic Modeling”, Oxford University Press, 1990.

<http://www.spiritustemporis.com/sudoku/history.html>

Ibidapo O. Akinyemi, Ezekiel F. Adebisi, and Harrison O. D. Longe (2009). “Critical Analysis of Decision Making Experience with a Machine Learning Approach in Playing Ayo Game”, World Academy of Science, Engineering and Technology 56.

Joe DeCapua (2011). “Report: Africa Not Prepared for Aging Population “ , Available from: <http://www.voanews.com/content/decapua-africa-aging-23nov11-134393698/159211.html>

Krans B. (2013). Dementia Drugs Ineffective at Slowing Mental Decline: [http://www.healthline.com/health-news/mental-cognitive-enhancement-medications-](http://www.healthline.com/health-news/mental-cognitive-enhancement-medications-dont-)
dont-

Meaghan O'Connell. “Ayo: The Yoruba Game Board”, Available from: <http://www.clarku.edu/~jborgatt/discover/1meaghan/ayo.htm>

Natashya Kristanna Pillay and Pranitha Maharaj (2013). “Population Ageing in Africa”

Olayinka Ajomale, Country report: Ageing in Nigeria – Current State, Social and Economic Implications, ISA RC11 ,*Sociology of Aging*

“Puzzles and Cognitive Rehabilitation”. Available from:
<http://www.sudoku professor.com/puzzles-and-cognitive-rehabilitation/>

P.K. Ayernor (2012). Diseases of Ageing in Ghana, Ghana Medical Journal, Volume 46, Number 2 Supplement

P. Maharaj (ed.), *Aging and Health in Africa*, International Perspectives on Aging 4, Springer Science+Business Media New York 2013

slow-mental-decline-091713

Russell Jon (2011). “Mobile tipped to grow 60% in Africa passing 1 billion subscriptions by 2016 ”, Available from: <http://thenextweb.com/africa/2011/11/07/mobile-tipped-to-grow-60-in-africa-passing-1-billion-subscriptions-by-2016/#!qkXim>

“South Africa Senior Home Care”. Available from:
<http://www.homeinstead.com/international/franchise-opportunity/Pages/South-Africa-Senior-Home-Care.aspx>

The Game of Ayo, Available from: <http://news.bbc.co.uk/dna/place-lancashire/plain/A833816>

United Nations. (2011). *World population prospects: The 2010 revision* . New York: Department of Economic and Social Affairs, Population Division.

United Nations. (2009). *World population ageing 2009* . New York: Department of Economic and Social Affairs, Population Division.

United Nations. (2007). *World population prospects: The 2006 revision* . New York: Department of Economic and Social Affairs. Social Affairs: United Nations Publication.