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Applications of Information Communication Technology (ICT) in Academic Libraries: An Overview of Turkana University College Library

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Abstract

Information is considered as need of human in the recent undertakings. In this paper the study has been done to research on application of Information communication Technology (ICT) and uses of ICT tools in Academic Libraries, with a focus on Turkana University College Library, to find out the application of ICT skills in Library Information Science professionals and to modernize the libraries. The study has been done in the School of Science and Technology and School of Education and Social Sciences, with the aims: (1) how students in these schools apply ICT in the library, and (2) how ICT tools are applied to provide innovative services to the users. This paper shows that the application of ICT tools is increasing in academic libraries especially from the two schools of Turkana University College, due to the development of technologies and according to the respondent ranking mobile phone is making it inevitable, due to easy access at any time anywhere.

Keywords: Library Information Science, application of ICT, academic libraries, ICT tools.

1. Introduction

Information is the key factor in any kind of research and development. The information itself and the way it is accessed have undergone changes owing to the development in information and communication technology. According to information it is considered as a fifth need of human beings after ranking air, water, food and shelter. Information technology entered into libraries, especially academic libraries and research libraries during 1960s. Quick and easy access to every required information is a supreme importance especially in academic libraries. Information processing, storage, communication, dissemination of information automation, further origin of Internet and development of World Wide Web, have revolutionized the information communication technology. Based on this, the application of ICT in libraries become essential to provide the facilities of the user community. Ebijuwa (2005) and ToAnyakoha (2005) define ICT as "tools and as well as means used for collection, capture, process, storage, transmission and dissemination of information." The American Library Association (1983) defines IT as "the application of computers and other technologies to the acquisition, organization, storage, retrieval and dissemination of information." The computers used to process and store data, while telecommunications technology provides information communication tools, which make it possible for users to access databases and link them with other computer networks at

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different locations. IT and ICT (Information and Communication Technologies) are used somewhat interchangeably.

The study reveals the drawbacks of the information access through print media. It elucidates the wide growing gap in volume of consumption between print media and electronic media by students of Turkana University College. The study is confined to the impact of ICT information on the access pattern of students studying at Turkana University College. The main aim of the study is to measure the respondents' ICT information needs and their information seeking behavior in collecting ICT resources. Further, their attitudes towards ICT information are also measured. It also proves how far ICT information make impact on the access pattern among the users of both professional and non-professional and the extent of ICT information being increasingly used rather than print resources. In the information communication technological world, knowing the respondents' changing attitude towards ICT information is very essential. In this context the study is needed in the present scenario.

2. Literature review

Walmiki and Ramakrishnegowda (2009) studied ICT infrastructure in university libraries and found that most of the libraries "lack sufficient hardware, software facilities and do not have adequate internet nodes and bandwidth." The campus LANs were not fully extended to exploit the benefits of digital information environment. Ahmad and Fatima (2009) found that researchers use a variety of ICT products and services for research and further remarked that ICT products help "to find information, access information more easily." It was recommended that training can be organized to increase the use of ICT-based products and services. Shafi-Ullah and Roberts (2010) found that ICT infrastructure lacked funding and recommended allocating funds for ICT infrastructure. K. S. Sivakumaren, Dr V Geetha and B. Jeyaprakash (2011) stated that the university libraries must increase the numbers of computer available to enable the users to maximize the usage of ICT-based resources and services and it is found that most libraries have not implemented digitization of library management software. It is very useful to digitize rare collections such as older and out of print editions. Mhammed Ijas Mairaj, Widad Mustafa EI-Hadi (2012) found that provision of hardware, standardized library software, adequate financial resources, and proper training facilities for medical libraries will help to strengthen ICT applications in medical libraries.

3. Applications of ICT in academic libraries

Nowadays there are several information communication technologies for various housekeeping, management and administrative functions of the library, different electronic and digital media, and computer aided electronic equipment, networks and Internet has provided significant role in retrieval and dissemination of information and playing a vital role for modernization of libraries.

3.1 *Library management*

Library management includes the following activities which will certainly be geared up by the use of these fast ICT developments: classification, cataloging, indexing, database creation, and database indexing.

3.2 *Digital library*

A digital library is an assembled of digital computing, storage and communication machinery together with the content and software needed to reproduce, emulate and extend the services provided by conventional libraries based on paper and other material means of colleting, cataloging, finding and disseminating information. A full-service digital library must accomplish all essential services of traditional libraries and also exploit the well-known advantage of digital storage, searching and communication. It provides access to part of or all its collection, such as plain texts, images, graphics, audio and video materials and other library items that have been electronically converted, via the Internet and www.

3.3 *Library automation*

Library automation is the concept of reducing the human intervention in all the library services so that any user can receive the desired information with the maximum comfort and at the lowest cost. Major areas of the automation can be classified into two-organization of all library database and all housekeeping operations of library.

3.4 *Library networking*

Library networking means a group of libraries and information centers are interconnected for some common pattern or design for information exchange and communication with a view to improve efficiency.

3.5 *ICT-based user services*

Some library users are adopting electronic habits, making increasing use of the new ICT including computers, the Internet, the Web, Intranet, Extranet and other technologies. As a result, library users are placing new demands on their libraries. They require access to the latest information, updated information resources and access to ICT facilities that they could use in their work. Use of ICT in libraries enhances user satisfaction. It provides numerous benefits to library users. Some of the benefits are:

- Provide speedy and easy access to information;
- Provides remote access to users;
- Provides round the clock access to users;
- Provides access to unlimited information from different sources;
- Provides information flexibility to be used by any individual according to his/her requirements provides increased flexibility;
- Facilitates the reformatting and combining of data from different sources.

Libraries are also providing various ICT-based services to their user, including the following:

- Provision of Web access to OPACs;
- Electronic document delivery;
- Networked information resources;
- Delivery of information to user desktops;

- Online instructions;
- Online readers advisory services.

4. Impact of ICT on libraries and librarians

Computer has brought in a new impact to the library and information usage. In libraries, information technology has assisted library professionals to provide value added quality information service and give more remote access to the inter-nationally available information resources. Today's highly sophisticated information technology to facilitate the storage of huge amounts of data or information in a very compact space. Information technologies promise fast retrieval of stored information and revolutionize our concept of the functions of a traditional library and a modern information center. Recently technological developments have dramatically changed the mode of library operations and services. Modern ICT is impacting on various aspects of libraries and the information profession. Advancements in ICT and the wide spread use of ICT is resulting in digital information sources and digital media replacing and becoming the dominant form of information storage and retrieval. ICT also survives and makes true rules of Library Science "every reader his/her book/information," "save the time of the reader," "library is a growing organism." ICT with its tremendous information sources, rapid transmission speed and easy access ensures the satisfaction of the user with complex demand, break down the distance barrier and shortened the time required and ensure the right information to the right reader at the right time. It also increases and solves the library's demand of collection development. It is really an excellent tool for the library information centers.

5. Components of ICT in libraries

ICT came about as a result of the digital convergence of computer technologies, telecommunication technologies and other media communication technologies.

Components of Information Technology (IT), which are frequently used in library and information center are:

- Computer technology;
- Communication technology;
- Reprographic, micrographic and printing technology.

ICT is the fusion of two important technologies: electronic and communications.

6. Methodology

The study was based on the primary data collected from students from School of Science and Technology and School of Education and Social Sciences who frequently use the University College main library. A structured questionnaire was designed based on ICT applications. The questionnaire was divided into seven major applications of ICT tools (e-group, e-mail, fax, Internet, Intranet, mobile phone, video conference), and 175 questionnaires were distributed among students. The sample of 175 was informed from data that was collected from the libraries and targeted students who did their studies in the library for at least three days during that week and have been a student from either school. Both primary and secondary data were used for the present research. Primary data have been collected from the users of academic libraries (students from school of Arts and Social Sciences and Information Communication and Media

Studies). The secondary data were collected from the web sites and prospectus of institutions, research journals, magazines, reports and conference proceedings.

7. Data analysis

The study was carried out in four libraries of Turkana University College (one main library and three Campus libraries) the information to these respondents is shown in Table 1.

Table 1. Information about respondents

S. No.	Description	Total (students)	Percentage
1	Main Library (1)	105	60%
2	Campus Libraries (3)	70	40%
Total		175	100%

Seven major applications of ICT tools, such as e-group, e-mail, fax, Internet, Intranet, mobile phone, video conference, were identified for this study and same is shown in Table 2.

The table and the figure show all the respondent uses all the facilities but the highest is mobile phone with (90%) and e-mail (89.09%), Intranet (86.36%) and Internet with (81.81%). The use of mobile phones is high due to its fast and easy way of communication.

Table 2. ICT tools for academic libraries

Sl. No.	Name of ICT Tool	No. of users	Respondent in %	Rank
1	e-Group	86	78.18	5
2	e-Mail	98	89.09	2
3	Fax	40	36.36	6
4	Internet	90	81.81	4
5	Intranet	95	86.36	3
6	Mobile Phone	99	90.00	1
7	Video Conference	30	27.27	7

Table 3. Use of ICT tools by gender

ICT Media	Male	Female	Total	Percentage (%)
e-Group	30	28	58	52.72
e-Mail	50	55	105	95.45
Fax	20	20	40	36.36
Internet	40	45	85	77.27
Intranet	14	16	30	27.27
Mobile Phone	53	55	108	98.18
Video Conference	15	13	28	25.45

Table 3 is a cross tabulation of ICT tools and gender and shows that female professionals are using mobile phones more than other media and female respondent use live video conference.

8. Conclusions and recommendations

The application of ICT tools is increasing in academic libraries especially in Information Science and Arts, and Science Schools of Turkana University College due to the development of technologies. According to the respondents, mobile phone is ranked first due to easy access at any time anywhere. There is a lack of LAN facility in most of the academic libraries, Turkana University College Library has LAN facility at Main Campus library, so the usage of Internet is less which was shown in the Table 3. Turkana University College Library should increase the video conferencing facilities which enables the users to maximize the usage of ICT based activities and services. It has been observed that not many libraries are offering video conferences it is due to fewer consortiums. If consortium with other libraries will increase the usage of video conferencing will also increase.

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Gamified Blood Donors System Based on Intelligent Agents

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Abstract

The population of the country of Kenya is drastically increasing thus causing the number of possible blood donors to rise. Despite this, the blood collected and stored in most blood banks is not enough to cater for the huge demand. The demand has been due to increase of number of accidents experienced in the country and the advancement in medical procedures which calls for organ transplant and blood transfusion. Even though systems have been developed which can connect the donors and recipients and location tracking, most people are dying because they don`t get this vital commodity in good time. The process of donating blood has not been enticing. There is nothing that prompts a person to donate blood. This call for developing a gamified blood donor management system based on intelligent agents so as to increase the number of donors and keep the system performance at optimal level. The project adopts Goal-Oriented Methodology in the system development process. Two agents are developed: donors' agent and the blood admin agent. The intelligent agents help in profiles personalization thus improving the system performance. Gamification technique is implemented in the system so as to increase the traffic of blood donors interacting with the system and participating in the donation exercise. This increase the number of blood donors hence enough blood is collected to cater for the huge demand.

Keywords: gamification, intelligent agents, blood donation system.

1. Introduction and background

1.1 *Introduction*

This chapter covers the background information, the problem statement, the research objectives, research questions, justification and the scope of the study.

1.2 *Background information*

Gamification is a technology that is bringing revolution in many of the applications used. This refers to the use of game elements and features in the real-life situation so as to motivate the public and increase their productivity in their work places. It's is aimed at improving the peoples' attitude and behavior towards certain tasks and activities. The use of gamification leads to drastic increase in number of users interacting with certain systems. This is because the game attributes motivate them and compels them to remain being active system users. This calls for having a well-designed system that is able to hold the huge user traffic without crashing or slowing down. Each and every organization is working very hard so as to increase the number of clients or

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system users. This can only be achieved if their system is stable, efficient and has some features which makes them feel being part and parcel of the organization.

Gamification technology having succeeded in business and commerce, it has been transferred into educational settings in the recent decade. It acts as a tool to deal with learner engagement, achievement and anxiety. Gamification promotes fun and entertainment in the learning process thus making it to be related to the flow theory. The major crucial component of flow theory is anxiety which radically affects the course of playing. The concept of gamification was benchmarked from the business industry to educational settings, and it has been the trending research topic of recent years. For many years, it has been successfully used for business purposes. In business settings, game elements, such as goal, competition, rewarding story and progress, are used to keep the clients in the system. For educational purposes, it is primarily used as a tool to enhance learner engagement and achievement. Gamification studies mainly revolve around motivation and engagement variables (Yavuz et al., 2020).

Blood shortage problem is experienced globally due to the small turn up of blood donors. This is due to lack of motivation factor in the donation process. Since gamification has succeeded in improving business and education industry, it is good if applied also in the blood donation sector. Development of applications that can facilitate users to motivate each other doing voluntarily and routinely blood donors, by gamification concept can help in curbing the existing challenge. Application of gamification successfully can trigger the users to donate routinely. Users get more enjoyable experience and make it easier to donate blood routinely (PrasetiantoWibowo et al., 2017).

Blood donation sector is faced with a lot of challenges in the process of executing their mandate. Despite the greater efforts geared towards registering more blood donors, blood collected is still not enough to cater for the huge demand. Applications have been invented to help manage blood donation taking into consideration all the functional requirements but still blood donors are not attracted to participate in blood donation exercise. Development of an intelligent blood donation system using SMS, based on strong and efficient database of donors and some major human characteristics can help in streamlining the donation process. All countries have now realized the need for regulation and implementation of a quality system as well as increased their efforts towards donor recruitment and retention. To meet the growing blood demand, some countries like Bangladesh, India, and Pakistan have launched web-based donor management systems. Donors register themselves on the sites, specifying their blood types and contact information; blood recipients do the same, specifying when they need what blood type. Sometimes blood recipients must specify months in advance of elective treatments because of donation shortages. It is anticipated that the introduction of gamified blood donation system can help in attracting more blood donors and in long run help in cabbing the blood shortage problem (Rahman et al., 2011).

A process that brings new mechanics to push users to be more engaged in blood donation need to be put in place. Blood donation is an activity which cannot attract people due to various reasons. This creates the need of applying game elements which can motivate people to participate in the blood donation process. Gamification in health is not just playing. Applications based on gamification need to revolutionize the way patients get involved with their treatment and improving their clinical condition. Blood donors and people demanding their donation can interact, know more about the donation process, and encourage this action among friends. All users can also receive rewards for their actions (Domingos et al., 2016).

The blood transfusion industry has started embracing the technology in its daily execution of its mandate towards making sure that we have enough blood for use in our hospitals. Human being cannot live without blood as it is a vital element required by the body for normal body functioning. It is the fluid we have in our bodies and is used to transport oxygen from the

lungs to the rest of the body. It also transports waste to be removed from the body. Human beings have between 4.5 and 6 liters of blood in their bodies. Millions of people require blood every year globally. Approximately 10,000 of pints of blood are required every day to help people. Due to deficiency of blood, people suffer from serious health issue and might even die. It is not possible to manufacture blood but with the help of advancement in technology in medical science field, blood can be transferred from one person to another. We can save a lot of peoples' life if blood donors are easily available. Sick people require blood for various reasons. A person might be suffering from anemia, lost blood through operation or may have been involved in a fatal accident. These patients might die for need of blood which is always not available. Pregnant mothers also may require blood during emergency situation (Diba, 2018).

Blood needs to be made available for use at all cost. Voluntary Non-Remunerated Blood Donors is the only source of blood in the country of Kenya. There is greater need of providing a way in which the donors can feel being part and parcel of the donation exercise. By use of gamification, we can manage to increase the number of registered donors and also retain them. The population of the country of Kenya has been drastically increasing thus causing the number of possible blood donors to rise. The demand for blood in our hospital also is increasing due to the number of accidents experienced in the country increases. Despite the large number of possible donors, we are still experiencing shortage of blood at our blood banks (WHO, 2014). This has led to loss of life which would have been prevented. Various measures have been put in place in sensitizing the public on the importance of blood donation but they have not been effective. Despite having large population of possible donors, the blood collected is usually not enough to cater for the huge demand. The existing challenge can be curbed if gamification is implemented in the blood donation industry so as to motivate the public to take part in this noble activity of blood donation. It is anticipated that the number of registered and frequent donors can increase once a gamified blood donors' system which has faster processing speed and efficient is put in place. This can be implemented by use of intelligent agents who aid in classification of the data collected and personalizing of each user profile.

1.3 *Problem statement*

The development of systems to manage blood donation process and help in curbing the blood shortage is witnessed globally. The population of potential donors has also increased drastically. Despite this, the blood collected and stored in most blood banks is not enough to cater for the huge demand as 90% of eligible donors don't participate in donation exercise (WHO, 2014). Even though systems have been developed which can connect the donors and recipients and location tracking, most people are dying because they don`t get this vital commodity in good time.

Various measures have been put in place in sensitizing the public on the importance of blood donation but they have not been effective. The conveying of the information to the public is usually done via conventional media means such as radio, newspaper or television advertisements occasionally especially when a tragic accident has occurred.

The process of donating blood has not been enticing. There is nothing that prompts a person to donate blood. This call for developing a gamified blood donor management system based on intelligent agents who motivates users to interact with the system thus increasing the number of donors and keep the system performance at optimal level. The increase in number of donors eventually lead to increase in amount of blood collected thus cabbing the blood shortage problem.

Gamification has emerged to be the solution for attracting more traffic by motivating the system users and making them fully engaged. The drastic rise of the number of system users comes in with its own challenges which may results in the system slowing down. The use of intelligent agents in the gamified system plays a big role in making sure that despite the huge

traffic accessing the system, the system performance is maintained at peak thus helping in system users' retention.

2. Literature review

2.1 *Introduction*

This chapter analyze related works, applications of gamification technology, gamification history, gamification drawbacks, current state of system performance, system's performance improvement via use of intelligent agents and propose a system that can help cab the existing challenges of blood shortage problem.

2.2 *Related works*

Several researches have been conducted on the concept of blood donation management system with most of them stating that computerization is a mechanism that help in achieving efficiency and effectiveness of the donation process. Development of blood bank data management system is seen as a solution to prevent near miss events and improve record retrieval. The computerization is aimed at fast retrieval of records which improve efficiency of blood banks operations (Bing et al., 2012).

Most of the systems used in blood banks have not been able to fulfill the purpose which they were designed for. There has been huge demand for blood globally as the number of advanced medical procedures increases (WHO, 2014). This has been as a result of the huge population in need of advanced medical procedures such as organ transplants and anemia treatment. Despite having large number of potential donors, the blood shortage is still experienced.

Technology advancement is felt even in the blood donation sectors. Applications are developed to help in managing various operations in the blood banks. New Zealand Blood application is used to schedule donation and was designed by Dialogue marketing. It is built with the capability of donor search, appointment scheduling or cancelation, registration of donors and profile management. It is a free application which is accessible to all the public (Nebraska, 2013).

The need to curb blood shortage led to development of Raspberry PI based blood bank system. This is an android application where the person who wants to donate blood needs to register so that his information is stored in the database. Application display three different screens such as Register, Query and about us screen. Donor needs to register his/her details such as Name, Gender, Address, Blood group and Mobile number. In query section patient needs to select required blood group and current address. Whole system is implemented using Raspberry PI kit. Whenever there is requirement for blood then patient enter required blood group details. Then that information is fetched from database and SMS is send to the donor directly on his number which is stored at the time of registration. Hence there is direct communication between donor and patient (Adsul et al., 2018).

Shimon Maman in the process of finding a solution to blood shortage build Bloody Help application. It was designed for connecting blood donors and patients. It has a donors' registration module which captures all his/her details. A blood search capability is added where the patient finds a possible donor and contacts them (BloodyHelp, 2016).

The existing blood shortage led to development of Life Saver App android application in which the blood donor is made available at required time. The donor who are all register in the application are displayed while searching for blood donation. The donor who are all nearby location are tracked by the GIS. The purpose of this application was to donate blood in case of emergency (Brislin et al., 2017).

Meiappane et al. (2019) proposed development of a system that help people by providing a list of blood donor and blood banks around the user at a certain radius and distance. A user can apply filters and search the specific need in the application such as availability of blood groups or donors having the same blood type. The system has an OTP verification and Validation of donor so that no third person can enter into the database as a volunteer. The system provides a donor tracking and locating system using Global Positioning System, by using Havesine Mathematical Algorithm which finds the nearest Donor.

E2M developed Blood Donation a free mobile application compatible with both android and IOS. It is used for searching hospitals addresses which have blood type compatible with the patient (E2M, 2017).

Keeping track of blood donors' records and their donation led to development of Blood Buddy which is a free iOS. It is used to remind them of the next donation period. It alerts the donors after duration of three months (BuddyBlood, 2016).

Game4Life is developed with the intention of engaging donors to schedule their next donation as they have fun collecting points for rewards. It also encourages future donors to register and donate their blood as it relays information of the importance of blood donation. After every donation, points are awarded to the donors (Sabani et al., 2016).

National Blood Transfusion Center, Khartoum having suffered from lack of central data references which was contributed by use of paper based system that was more time consuming in data retrieval and has no security prompted the development of a central blood bank management which provided real time information about blood component, grouping donor information from collection to testing and use of the blood product (Esmail & Osman, 2018).

Lack of direct contact between the donor and recipient contributed to development of blood bank database created by collection of details from various sources like Blood banks, NSS, NGOs, hospitals and through web interface. The data collected was maintained in a central server. An algorithm was designed to help retrieve the donor's information by a recipient and a call initiated. The ingress of donor and the closeness of the donor to the place from where the call is coming were accounted for in defining this algorithm. Based on the algorithm the most eligible donor were found and the blood donation process was effected (Arif et al., 2012).

Blood hero application was invented with the aim of helping curb the blood shortage. This was as result of the WHO report which stipulated that only 3% to 5% of each country population participate in the blood donation exercise. The study showed that there was need to clarify the blood donation process. This led to the development of the Blood hero system whose aim was to incorporate gamification reward attribute so as to motivate people to register as donors and eventually help in reducing the blood shortage. Gamification act as a mechanism to push users to be more engaged (Domingos et al., 2016).

2.3 *How agents work?*

Various researches have been conducted on how intelligent agents' function. This aimed in learning more about their behavior and their interactions. Cooperation and competition are the major techniques which are discovered to be used in their mandate execution. It clear that during cooperation, agents tend work together and draw on the broad collection of their knowledge and capabilities to achieve a common goal and they fail or succeed together. Sometimes agents may have conflicting goals, this results in competition where they work against each other and thus the success of one agent implies the failure of the other agents. Negotiation is portrayed to be a vital skill for effective agents functioning in accomplishing their task assigned. The agents

need to come to a mutually acceptable agreement on some matter which is achieved by convincing each other to undertake a certain activity depending on the conditions given.(Jennings et al., 2016)

Jennings et al. (2016) stipulates some techniques applied during the negotiation process. The techniques are Game theoretic techniques, Heuristic techniques and Argumentation based techniques. An analysis of these techniques states that agent issues a proposal which can either be accepted or rejected. During rejection, the reason for rejection is stipulated which allows the agent issuing the proposal to issue a counter offer stipulating why the other agent should accept the proposal. Coordination of agents needs to be put into consideration. A contract net protocol is used to help in agents' coordination. An agent acting as a manager decomposes its contract into subcontracts to be accomplished by other potential contractor agents. For each subcontract, the manager announces a task to the network of agents. Agents receive and evaluate the announcement. Agents with appropriate resources, expertise, and information reply to the manager with bids that indicate their ability to achieve the announced task. The manager evaluates the bids received and awards the task to the most suitable agent, called the contractor. Finally, manager and contractor exchange information together during (Jennings et al., 2016).

2.3.1 *Intelligent agents in e-learning systems*

The education filed has not been left out. Various systems have been put in place which aids the learners in knowledge acquisition. Most of this system applies intelligent agents where by the learners' contents is personalized depending on their age, skills possessed and their learning speed. To increase the interactivity with such kind of systems, gamification is applied so as to motivate learners to keep on using the systems. Rewards and learning levels are given as the learning progresses with accessing the learning materials and covering various topics.AI makes digital systems learnable. Some of these systems have the ability to learn about its user's peculiarities like player's intentions. Artificial Intelligence which makes a digital system have the ability to learn about users is the key to making educational gamification adaptive more effective to varying human learners and trainees. Personalization of different learners and the impressive interactive platform brought about by gamification technique makes education advantageous over conventional approaches (Arnold & Jantke, 2018).

2.3.2 *Gamification of businesses*

Most of the businesses have embraced the use of gamification. Their main aim is to attract more clients visit their stores so as to receive services. For the advertising companies, they have been applying personalization technique where they send to clients' social media accounts goods similar to the one they had purchased. This reduces the time a client takes in search of goods in their online stores. In order for Malls and supermarkets to retain their customers, they have introduced the use of Loyalty cards. Members accrue points, normally based on dimensions of the volume, value and frequency of spend. Later on the customers are given company's product or service towards points' redemption as form of reward for their loyalty (Wathigo, 2016).

Communication companies are not left behind in the process of increasing the number of their subscribers. Safaricom introduced the issuing of Bonga points to their client on every amount of credit spent. Once the bonga points have accumulated, the customers can redeem them and in return given free airtime, SMS or even tangible goods like phones. This has greatly increased the number of Safaricom subscribers. Safaricom has gone further and introduced more activities geared towards attracting more customers by rewarding them (Safaricom, 2014). Recently we have distance system where they are rewarding their faithful customers all-over the country. This is done by randomly selecting customers from their database and the selected customer is given a token of appreciation (Safaricom, 2019).

2.4 *Gamification history*

The use of games has drastically changed thus introducing a new concept known as gamification into the technology field. In 1992, the first form of gamification was brought forward in form of a toy. For approximate sixty-eight years, no notable improvement took place in gamification field up to 1980. After this timeline elapsed, Richard Bartle helped in creating a multiplayer game online which was known as MUD1. It was the first online game which people could interact with globally. This was the era when computers had not evolved so much as compared to what we have today. MUD1 helped to shape the past of gamification and the its future. In 2002, a serious gamification element was introduced by bringing in board real games. Some of these games were used for training purposes via simulation. This helped in creating path for introduction of real gamification. The first platform for gamification was developed in 2007 by Bunch-ball. This allowed other organizations to start launching products which utilized the gamification technique to increase their sales and traffic. Gamification has become a very profitable field of study which has been aided by the internet in variety of devices. This has become one of the most competitive filed which everybody wants to venture in. Every organization is working hard to implement gamification in their systems (Nielson, 2018).

2.5 *Gamification drawbacks*

Introduction of gamification in the industry is bringing drastic changes by increasing the number of clients and customers. Despite the best part of gamification being felt, the industry is face with some few challenges which can be addressed to make it more effective (Rajamani & Sharma, 2017).

Gamification is a tool that simplifies concepts. It is designed for a purpose. Developing both the tool and purpose is extremely complex. The level of complexity involved in both designing and managing the entire gamification system is immense. The misusing gamification in a training course result in wasted resources and also the learners won't have patience with a game once they discover it has no real purpose or it was created haphazardly. If you don't have a design or technical skillset, but you know a mini-game is the one thing that elevate your course to the next level, then it's time to spend some time with a game designer. Explain the learning objectives, discuss possible execution options, and, most importantly, listen to what the designer says. The extra work you put in to this process always comes through in the final product, which translate into a better result for the learners (Rajamani & Sharma, 2017).

Gamification if introduced without seriously considering its purpose might lead to wastage of a lot of time. Not all game attributes need to be implemented on every system. Worst choice of the attributes can jeopardize the whole system. The game attributes implemented needs to be in line with the organization main objective which need to be accomplished (Jayme, 2016).

Introduction of gamification technique acts as crowd sourcing process. Huge traffic of users is drawn towards interacting with the gamified system. This calls for utilization of a lot of the system resources. As the traffic continues to grow, the system eventually slows down. No one likes interacting with systems having long response time thus once the system execution time increases, the system users feel discouraged thus making them to stop interacting with the system. There is greater need of considering the system architecture in its development so that all aspects needed to make it handle a huge traffic are implemented during its design (Werbach & Hunter, 2015).

Despite having so many applications developed to aid in blood donor management, blood shortage is still experienced. Most of these applications concentrate more on the functional requirements but do not focus on changing the blood donors' behavior (Sabani et al., 2016). Game4Life and Blood hero applications apply gamification technique to help in encouraging blood

donors to register and to be actively involved in the donation exercises though it does not provide a way to handle and manage the huge traffic of blood donors interacting with the system.

2.6 *Current state of system performance*

Complex applications are designed daily. This is achieved via integration of so many subsystems developed using different technologies and platforms to accomplish certain goal. Component based programming is applied in order to deliver these systems in good time without delay. The integration with other external API's helps in embedding more functionality into the system thus making it possible to provide various services using one system. Centralization of all the services increases the number of transactions conducted via use of a single application as it help save time (Simic et al., 2013).

Invention of powerful computer hardware which has the ability of supporting complex applications is witnessed. Powerful cloud-based servers which have the faster processing speed have been introduced. All this effort is aimed at increasing system performance. Technology advancement is felt globally. All the organizations are working very hard in embracing the new technology introduced. Everybody is excited by the new systems invented daily and no one wants to lag behind. This has been spearheaded by the vast usage of the internet. Most of the devices are connected to each other thus simplifying the process of communication. It is believed that in the near future, all the devices are able to communicate and share information. This is possible by the use of Internet of Things (IOT), Smart technology and also by use of Artificial Intelligence (AI). Due to the increased number of operations to be executed by the systems and also the increased number of users, the performance of most systems is affected. This has been a major concern to most of the computer hardware developing companies. These companies have worked around the clock so as to optimize their devices so as to increase the performance. Upgrading of the hardware components of the computer devices has been made and very powerful devices which have high RAM capacity, faster processors, higher graphics performance and large storage capacity have been introduced. Despite all the efforts geared towards improving the computer performance, inefficiency in the performance is still experienced. Every system developer is working hard to design and develop systems which meet the clients' functional requirements. This is implemented via Rapid Software Development methodology (RSD). The software architecture which is the aspect of systems has been neglected. Every developer is working hard to implement the clients request but not taking into consideration the software architecture. This has led to development of systems which are not able to exploit efficiently the resources provided by the computer hardware thus leading to inefficiency. Companies have opted to purchasing very expensive super computers so as to cab the performance issue but it has all been in vain. This has resulted in establishment of blame game where nobody wants to take full responsibility of the overlying performance challenge. The system developers blame the hardware and network engineers and vice versa. The number of users interacting with the systems has drastically reduced (Simic et al., 2013).

2.7 *System performance improvement via use of intelligent agents*

The amount of information currently available via the internet is increasing rapidly. Mining meaningful information from these huge databases of data might be tiresome. Retrieval of the information has become a major challenge as it is not easy for users to locate relevant information they need in good time. Most organizations have databases containing all the daily transactions conducted by each client. Systems have been put in place to aid the clients get access to their records from any location of the world. The systems query the main database to access

details of each user who is interacting with the system at any given time as they try to retrieve their data (Jansen, 2012).

Organizations are embracing the use of gamification technique which automatically increases the number of clients interacting with the systems. This brings success in the business as the number of transactions conducted improves. In the learning industry, the students become motivated and they engage in the learning system more often. This creates a huge traffic on the gamified systems. With the huge traffic, a lot of data is stored regarding each participant interacting with the system at any given time. Retrieval of these data in real time by each user tends to be challenging as the system slows down as a result of not able to cater for the huge traffic (Jansen, 2012).

The introduction of autonomous, intelligent agents has come to help cab the overlying system performance problem. This is done via personalizing each user's content depending on their age, location and any other feature which identify them uniquely for easier data retrieval. This can be done via use of classification method of machine learning where the data in the databases is grouped into various classes. Each uses only interacts with data in the class holding his/her information. This makes data retrieval easier thus increasing system performance by reducing the response time. The reduced response time increases system efficiency thus helping in retaining the users interacting with the system thus the organization goal of use of gamification is achieved (Jansen, 2012).

2.8 *Conceptual framework*

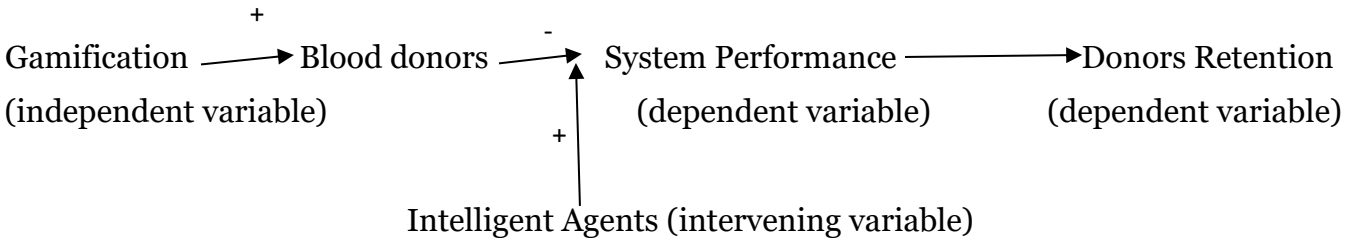

Figure 1. Conceptual framework

Introduction of gamification technique in blood donor management system increase the number of registered blood donors. This eventually increase the traffic of users interacting with the system. The increase in users affect the system performance negatively and it might slow down thus discouraging users from continuing using the system due to long response time. The introduction of intelligent agents in donor's profile management help in system optimization thus improving its performance and hence improve blood donors' retention rate.

3. Research methodology

3.1 *Introduction*

This section describes the principles, rules and stipulated procedures to be used in the project. This section focusses on project design, system requirements, and technology used, system functionality and system development process.

3.2 *Research design*

Qualitative design is adopted in this project in line with the research objectives which are qualitative in nature. The research is aimed at changing donors' behavior by introduction of gamification technology. This cannot be quantified thus making it suitable to use qualitative research design.

3.3 *Methodology*

An iterative methodology is adopted in the system development. At the beginning, a prototype of the blood donor system is designed and developed. Additional functionalities are incorporated in the system in various iterations. The design modifications are made and new functional capabilities added in every cycle. The iterations continue until the development is completed. This methodology enables the user to evaluate the system functionality periodically until the final product is delivered. This creates rooms for capturing new requirements and implementing them.

Figure 2. Iterative methodology

3.3.1 *Planning phase*

The methodology to be used is selected in this phase. Iterative methodology has been chosen as it helps the user acquit him/her with functionality of the system before it is fully completed. The requirements for developing an intelligent blood donor system are examined carefully. The major goal is to increase the amount of blood collected and stored in the blood bank. This involves raising the number of potential donors via using gamification technique to motivate the donors and help retain them. This is achieved via development of a gamified blood donor web system based on intelligent agents.

3.3.2 *Analysis*

In this phase, the specifications of the gamified blood donor system are studied based on the problems that have been identified in planning phase. Analysis is performed to point out the appropriate business logic, database models and to know any other requirements of this particular stage. The agents to be developed are identified in this stage. These agents are the blood donor agent and blood admin agent. These two classes of agents cooperate in their functionalities so as to enable the blood donor system function well. The donor agents interact with the donors' records while the blood admin agent conduct analysis on all the records received in the system.

The system architecture is stipulated in this stage. The system store records of all registered blood donors, the number of times they have donated blood, the rewards they have obtained and the level they are at. MYSQL is used as the database management system.

This is a web-based system which is developed using Laravel framework. This is powerful Model View Controller (MVC) framework which helps in creating full featured web applications. HTML5, JavaScript and CSS are used for the front end development, while the back end is developed using Object Oriented PHP.

3.3.3 *Design and development*

The design of blood donor prototype is produced in this phase. The requirements captured in the previous phases is used to develop the system. Laravel PHP framework is used in the development of the web-based system. The donor agent and the blood admin agents are developed in this stage. The gamification technique is embedded in the system via awarding of points to donors. Personalization of the user profiles is implemented.

3.3.4 *Testing phase*

After the current build iteration is coded and implemented, testing is initiated in the cycle to identify and locate any potential bugs or issues that may have been in the system. The system testing is carried out in each iteration so as to determine if all the user requirements are well captured and implemented.

3.3.5 *Evaluation phase*

This is the final phase of the iterative life cycle. If there are bugs and requirements not met in testing stage, the development is subjected to another iteration. If no bugs found, the blood donor system is deployed for use.

4. Conclusion

The aim of each and every organization is to increase the number of clients/customers whom they server so as to maximize on their profits. For learning institution, their main aim is to produce learners who have the required skills. Depending on the nature of activity executed in any organization, how to increase the number of users interacting with their systems and getting value of it is a big concern. Retention of the users for long also is emerging to be another challenge. For all these to be possible, there is greater need to have a system that can help in crowdsourcing so as to increase the traffic of users visit the organization system.

Gamification has emerged to be the solution for attracting more traffic by motivating the system users and making them fully engaged. The drastic rise of the number of system users comes in with its own challenges which may results in the system slowing down. The use of intelligent agents in the gamified system seems to play a big role in making sure that despite the huge traffic accessing the system, the system performance is maintained at peak thus helping in system users' retention.

It is believed that the introduction of a gamified blood donor system based on intelligent agents help in increasing the number of registered blood donors. The frequency of donation of blood also increases as the donors become engaged in the donation system. The feeling of ownership of the donation exercise is created and every citizen feel being part and parcel of the

practice. This result in having plenty of blood in all the blood bank enough to cater for the huge demand experienced. Via personalization of donors' profile by use of intelligent agents, the performance of the system won't be affected by the large number of donors interacting with the system thus improving blood donors' retention rate. The deaths caused due to lack of blood in the blood banks drastically reduce. This makes it important to research on the contribution of gamified blood bank management system based on intelligent agents in blood donation sector.

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Reinforcement Learning Approach for Adaptive e-Learning Based on Multiple Learner Characteristics

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Abstract

We introduce a novel three stepwise model of adaptive e-learning using multiple learner characteristics. We design a model of a learner attributes enlisting the study domain, summary details of the student and the requirements of the student. We include the theories of learning style to categorize and identify specific individuals so as to improve their experience on the online learning platform and apply it in the model. The affective state extraction model which extracts learner emotions from text inputs during the platform interactions. We finally pass the system extracted information the adaptivity domain which uses the off-policy Q-learning model free algorithm (Jang et al., 2019) to structure the learning path into tutorials, lectures and workshops depending on predefined constraints of learning. Simulated results show better adaptivity incases of multiple characteristics as opposed to single learner characteristics. Further research to include more than three characteristics as in this research.

Keywords: reinforcement learning, adaptive learning, learner characteristics.

1. Introduction

Increase in learner enrolment has forced higher education institutions to look for effective ways in which they can reach many learners. One of the strategies deployed by higher education institutions is the use of e-learning. According to Steinbacher and Hoffmann (2015) this involves inclusion of digital tools for learning delivery and employing technology to enable learning to take place without limitation of time and location. The study by (Hadullo et al., 2018)also mentioned inadequate academic staff to facilitate online learning, poorly designed and course materials that are not interactive as challenges faced by learners in online learning. There is therefore a need to improve the quality of e-learning. One advantage that face to face learning has over online learning is the ability of learners to get immediate feedback and clarifications on areas they are facing difficulties (Linecar & Marchbank, 2020). Effort in research has gone into personalizing learning by making learning management systems adaptive (Sethi & S Lomte, 2017). In the effort to improve the quality of e-learning to cater for learners needs, researchers have made and developed adaptive learning systems.

Research in adaptive learning goes back in the1990s. During that time researchers were looking at two major areas: hypertext and user modelling (Ennouamani & Mahani, 2017). Research in adaptive learning has grown ever since. One of the major areas of researches in adaptivity in e-learning at current is in learner modelling (Premlatha & Geetha, 2015). Chrysafiadi and Virvou (2013), and Raj and Renumol (2021) listed the different approaches for modelling

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learner characteristics as follows: overlay; stereotyping; perturbation; machine learning techniques; cognitive theories; constraint-based models; fuzzy learner modelling; Bayesian networks; and ontology-based modelling. According to Chrysafiadi and Virvou (2013), learner modelling is the foundation for adaptive learning.

Several researchers have used different techniques to develop the learner's models. These techniques have been classified into two: static and dynamic methods. Static methods involve collecting information about learners by having them fill out a questionnaire. According to El Aissaoui et al. (2018) this method does not lead to accurate detection of learner's learning styles as learners are usually un aware of their learning styles. For dynamic methods learner characteristics are collected while learners interact with the system (Ennouamani & Mahani, 2017). To create learners' models, many researchers are now focusing on the use of dynamic techniques.

Sethi et al. (2017) identified the needs to be filled in adaptive learning systems as: ways of identifying and confirming learning styles; automatic learning styles identification process improvement; improving agents guiding the learner during the learning; ability to tract learning behavior; and basing adaptive LMS on learner assessment.

2. Literature review

This chapter introduces adaptive learning, e-learning, a review of learning theories and their relations to adaptive learning. Next it reviews researches on learner characteristics in an e-learning environment, e-learning models based on various learner characteristics. The chapter also gives the overview of Artificial Intelligence (AI) techniques used in adaptive e-learning systems.

2.1 *Theories of learning in adaptive e-learning*

Significant advancements of technology birthed with it, tools, environments and procedures for aiding learning and brought in a number of changes in learning environments and the way people learn keep on changing or will be made to change in conformity with the merging trends and technological issue. However, Havard et al. (2016) advocates that the implementation of technology in learning should not be in isolation but be driven by the way people learn. In this section, we review some of the learning theories that has been fronted to enhance adaptive learning by various researchers.

Quite a number of learning theories have been fronted by various researches in order to address the online-learning. From Hadullo et al. (2017), the following learning theories have been looked into and proposed as theories which can make e-learning effective; the social constructivism, the theory of network, the cognitive load theory and the connectivism.

Constructivism, behaviorism and cognitivism are the main learning theories that have been the building stones for the learning and instruction process. Some researchers glide deeper and bring suggest specificity; Hammad et al. (2018) advocates for adaptive systems to based principles of constructivist, behaviorist and cognitivist on the higher scale.

According to Dalgarno (2001), a constructivist envisions learning being the knowledge construction process by building understanding based on past experiences and inputs making shift in focus from teaching to guiding learners so that the learners themselves construct knowledge. In Behaviorism learning is viewed as a response to external stimuli from environmental state-actions reinforcement activities so as to achieve the set specific objective.

Cognitivism, relates learning to a computer process as it defines learning as a process of acquiring, storing and retrieving information.

Table 1. Learner characteristics and theories of learning in adaptive e-learning systems

Authors	**Studied Learner characteristics**	**Theory**
(Almohammadi & Hagras, 2013b)	Learner knowledge	Cognitivism
(Deeb et al., 2014)	Learning style	Cognitivism
(Fenza et al., 2017)	Learner knowledge	Cognitivism
(Kolekar et al., 2010)	Learning style	Cognitivism
(Rajendran et al., 2018)	The learner's Affective states	Cognitivism
(Malpani, 2011)	The Learner's Prior knowledge and current knowledge level. This was done by measuring the ability of the learner to answer quizzes correctly	Cognitivism
(Sabourin et al., 2011)	Learner effect	Behaviorism
(C. H. Wu et al., 2017)	Learner knowledge	Cognitivism
(Alshammari et al., 2015)	Learning style	Cognitivism
(Whitehill & Movellan, 2018)	Learner knowledge	Cognitivism
(Hwang et al., 2013)	Learning style	Cognitivism
(Yang et al., 2016)	Both the learner's Learning style and cognitive styles	Cognitivism
(S. Y. Chen et al., 2016)	Cognitive style, gender differences	Cognitivism
(C. M. Chen & Li, 2010)	Learner context	Constructivism

From the studies as show in the various researches tabled in Table 1, most if not all of the adaptive e-learning systems failed to incorporate the three learning theories. The common theories among the studies is cognitivism and all the studies are mono-theoretical as learning theories are concerned.

For those studies that based their adaptivity in e-learning systems based on theories of learning, they just utilized one aspect of the learning theories. The aspect of how learners process information was the most utilized aspect of cognitivism. There is therefore a need for adaptive e-learning systems to be based on the whole principles of the learning theory so that we can tell if the outcome was because of basing the system on a particular learning theory.

Since most of these concepts of how learning occurs are build based on the weakness of the preceding concepts, there is need of combining the learning theories principles when building adaptive e-learning systems in order to be able to explain learning properly

2.2 *Learner characteristics and adaptive learning systems*

Most adaptive systems have succeeded in most cases where their profound abilities have been based on the accuracy in assessing general and specific learner characteristics (Colchester et al., 2017). This is what informs learner modelling to bring out the adaptation based on learner characteristics. Deciding which learner characteristic to be part of the learner model is usually a challenge (Nurjanah, 2008). Learner characteristics can be static or dynamic. The classification is applicable during modelling. Static learner characteristics include such objects such as name, age, email which do not change during the actual leaning or simulated learning. The collation of such are done through applicable questionnaires customized backed with both front end and back end for such data. Adaptivity in e- learning system may be classified dichotomously as static and dynamic. Dynamic characteristics of the learner include such features that are

acquired as a result of interactions with the environment, which complicates their modelling specificity rather than modelling their applicability (Chrysafiadi & Virvou, 2013).

Table 2. Summary of learner characteristics used in different adaptive systems studies

Authors and Title	Learner characteristics
(D. Wu et al., 2015) A fuzzy tree matching-based personalized E-learning recommender system	Preferences
(Tadlaoui et al., 2018) A learner model based on multi-entity Bayesian networks and artificial intelligence in adaptive hypermedia educational systems	Learner knowledge
(Alshammari et al., 2014) Adaptivity in E-Learning Systems	Learning style, learner knowledge and learner preferences were found to be the most used learner characteristics in the learner model
(Kanimozhi, n.d.) An Adaptive E-Learning Environment Centered On Learner's Emotional Behavior.	Emotional behavior
(Almohammadi & Hagras, 2013b) An Adaptive Fuzzy Logic Based System for Improved Knowledge Delivery within Intelligent eLearning Platforms	Learner knowledge
(Deeb et al., 2014) An Adaptive HMM Based Approach for Improving E-Learning Methods	Learning style
(Ennouamani & Mahani, 2017) An overview of adaptive e-learning systems	Source of adaptation (learner, device, environment)

2.3 *E-Learning models*

Learner models inform the foundations of adaptation in e-learning (Ding et al., 2018). Various models have been explored, developed and aligned to help model varied learner characteristics. Rabat (2016) considered Andragogy and self-directed learning, adult learning theories, to come up with a learning adaptive e-learning model. They encompassed in their modeling, prior knowledge, affective states, personality traits, cognitive characteristics, personal characteristic and knowledge. Mejia et al. (2017) considered people with disabilities in their model and so their setup consisted of demographic data, competencies, reading difficulties, and cognitive traits. Mejia et al. (2017) did not consider any learning theory. Huang et al. (2017) placed the learner I a contextual environment and modelled learner's context with regard to social context, cognitive levels, basic information, learners learning style, learner preferences and related interests. Ding et al. (2018) also considered fundamental initial information, the learner's style of learning, the learner's cognitive abilities and the learner's prior knowledge state in their model. From Huang et al. (2017) and Ding et al. (2018) in their models did not take into account any learning theory.

Table 3. Summary of existing learner models

NO	Authors	Characteristics in the model	Theoretical underpinning
1	(Rabat, 2016) Towards an Adult Learner Model in an Online Learning Environment	Personal, cognitive, social, personality traits, emotional traits, cognitive and knowledge	Andragogy and self-directed learning
2	(Mejia et al., 2017) Inclusive Learner Model for Adaptive Recommendations in Virtual Education	Demographics, competences, reading difficulties, learning style, cognitive traits	No learning theory
3	(Huang et al., 2017) Research on Individualized Learner Model Based on Context-awareness	Basic Learner information, learner cognitive levels, learner learning style, and learner interest preference	No learning theory
4	(Ding et al., 2018) A New Learner Model in Adaptive Learning System	Basic Learner information, the learners learning style, the cognitive abilities of the learner and the prior knowledge state of the learner	No learning theory indicated

2.5 *AI techniques applied in adaptivity in e-learning systems*

AI Tools are seen to be appropriate tools to model learners as they exhibit the abilities of replicating human decision-making process. Some of the AI techniques that have been used for constructing learner models include; fuzzy logic, neural networks, Bayesian networks, and hidden Markov models (Almohammadi & Hagras, 2013a). AI techniques have been used in two ways; one is for classifying learners into groups to provide adaptation to those particular groups, two is for diagnosing the learner characteristics as learners learn so as to adjust the instruction method.

Fuzzy logic is seen as an extension of set theory, Fuzzy logic is usually used to assess learning and knowledge of the learner. It has been used in several studies to make adaptation based on learner's knowledge. Almohammadi and Hagras (2013a) used fuzzy logic to extract rules from learner data so that they could tell the knowledge needs of learners. Aajli and Afdel (2017) use fuzzy logic to automatically generate the domain model of the adaptive e-learning systems.

Bayesian networks are directed acyclic graphs which are usually used for modelling variables probabilistic dependencies (Liu et al., 2006). Bayesian networks have been used in adaptive systems in order to provide adaptive instruction. For instance, Liu et al. (2006) use Bayesian networks to assess the learner knowledge and provide instruction as per the learner knowledge; Firte et al. (2009) use Bayesian network to classify users based on their navigation habits and then suggest content based on the classification; Guan et al. (2013) use Bayesian network to provide learning path adaptability by first constructing the domain module using a Bayesian network; Ueno and Okamoto (2007) use Bayesian network to provide motivational messages based on the learner logs.

Hidden Markov models have been used in adaptive e-learning systems. For instance, Deeb et al. (2014) used the K-means algorithm together with the Hidden Markov models to cluster learners into different learning styles and adapt content to suit the learner learning style; Rani et

al. (2017) used fuzzy petri nets and hidden Markov model to adapt learning content to each learner in accordance with the learner's learning path.

2.6 *Conceptual framework*

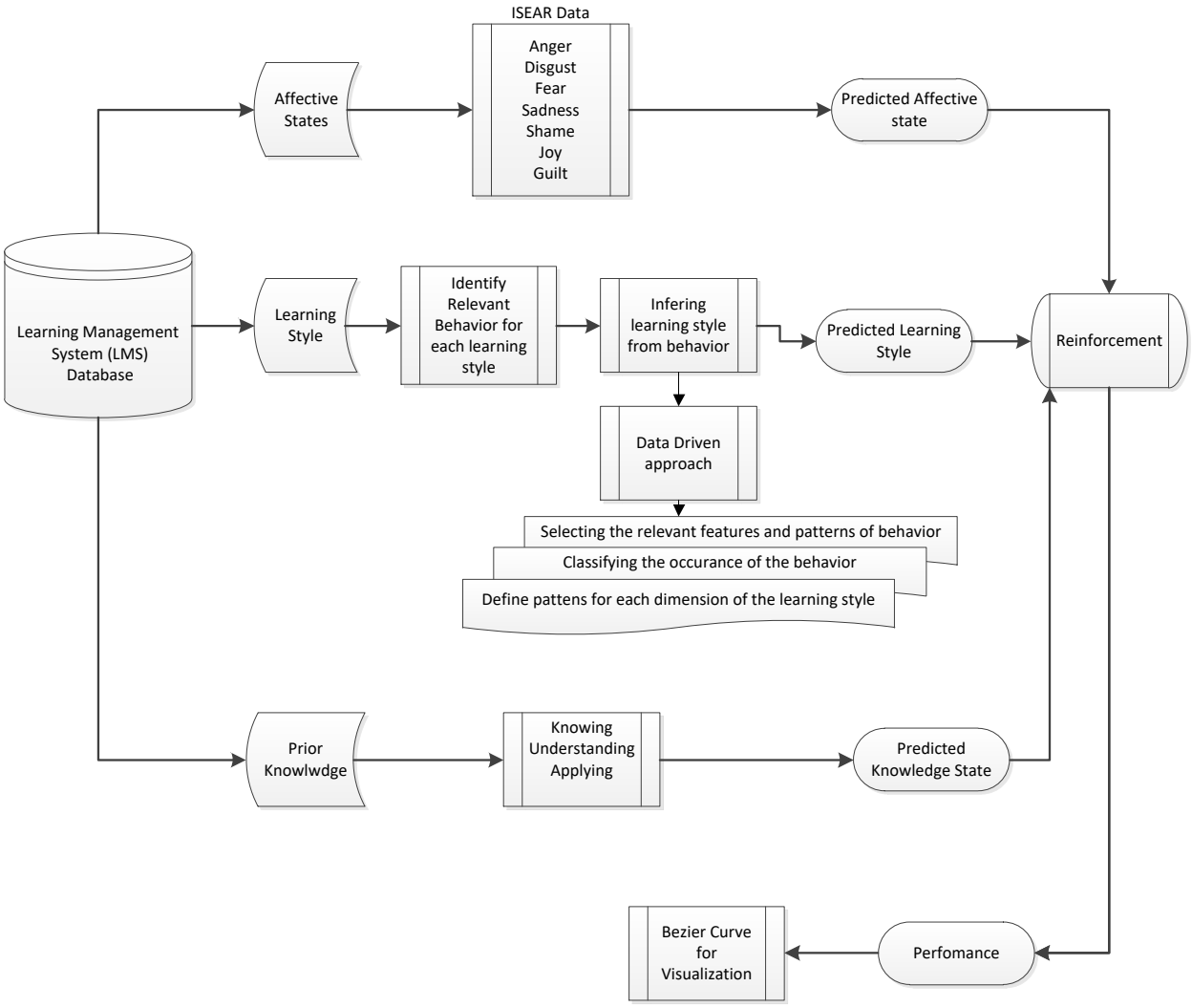

Figure 1. Conceptual framework

3. Methodology

This research adopted iterative incremental methodology. This is a time-based stepwise software development process and each step defines a definitive block that keeps expanding the model. It begins with initializing the specification to create a basic model. From the initial complete model, user testing process is carried out which gives the user feedback which informs need for specification adjustments and model incremental expansion. The process is repeated till the model becomes functionally complete and acceptable application meeting all requirements put forth by the project. See Figure 2.

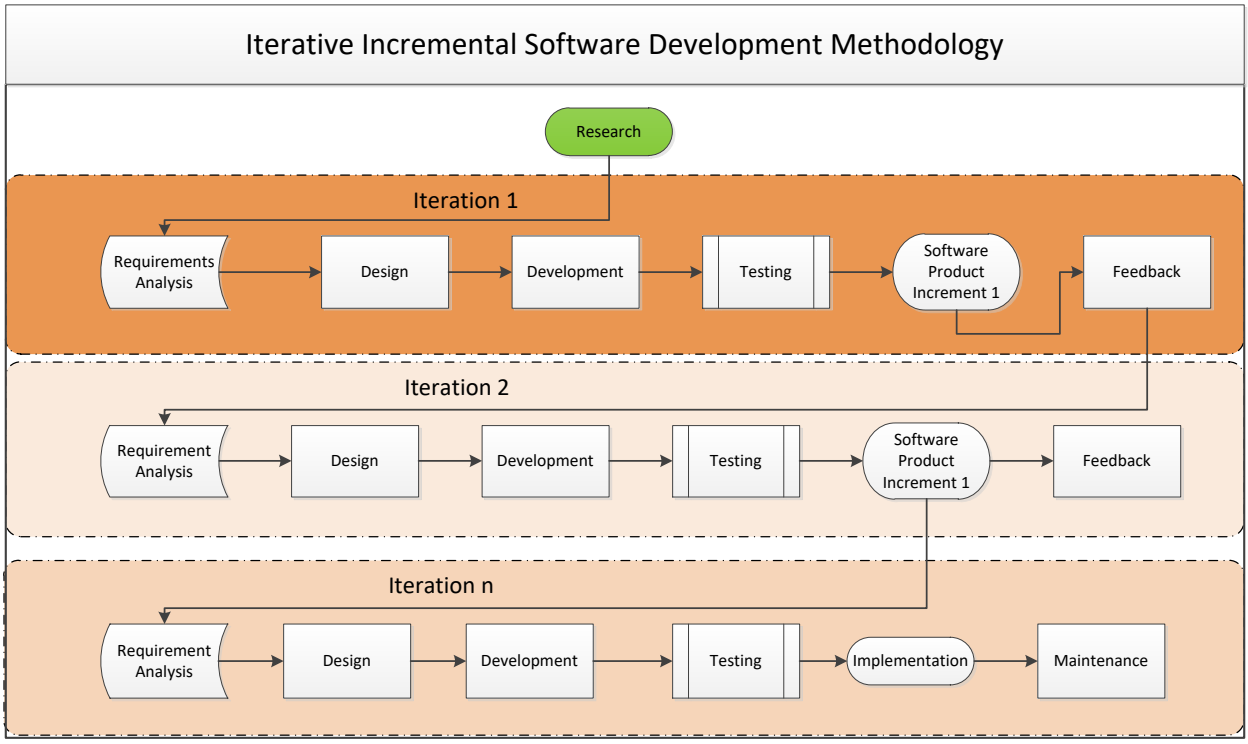

Figure 2. Iterative and incremental methodology

The project feedback is received after each iteration is completed.

3.1 *Model architecture*

The *Reinforcement Learning Approach for Adaptive E-learning Using Multiple Learner Characteristics (RELUMECEL) Model* Framework gathers learner characteristics, learning style, affective state and prior knowledge the give recommendations on the instruction design of contents best suited for individual learner based on the three characteristics. It also gives the best learning path for a learner revisiting the e-learning environment as well as giving the content developers the required updates needed so as to achieve adaptability for various learners represented in the given learning environment.

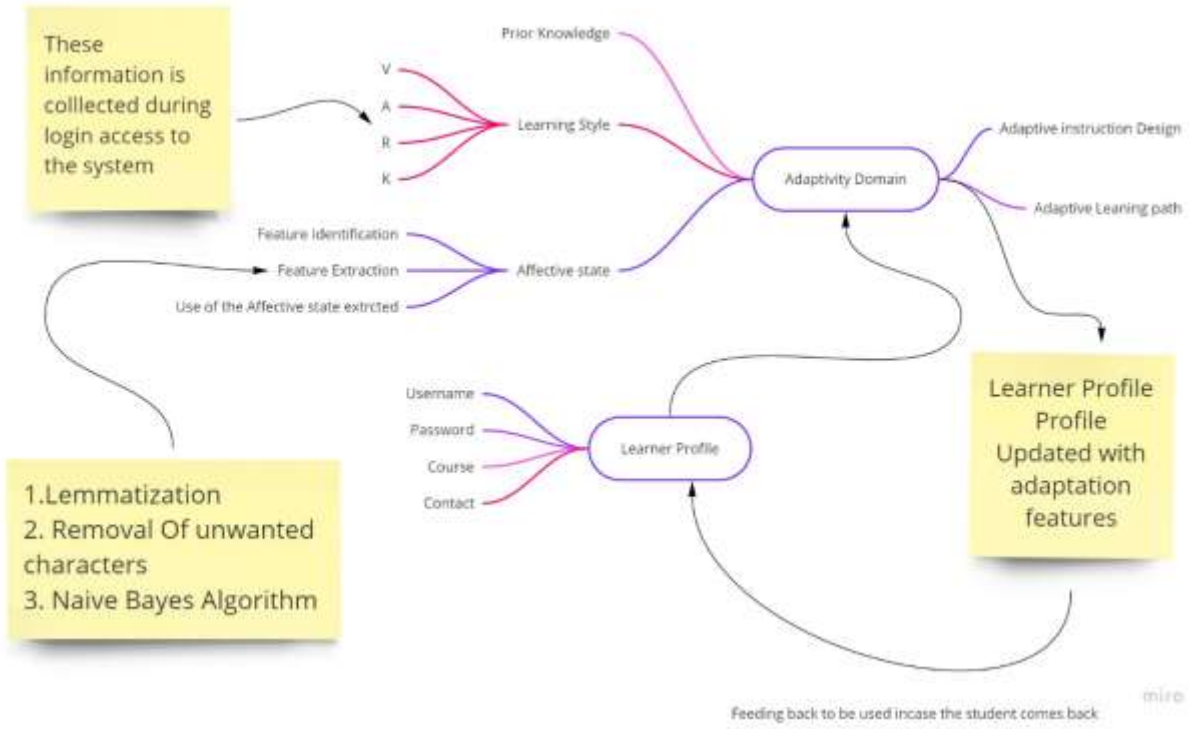

Figure 3. RELUMECEL Model architecture

3.1.2 *The learner domain*

RELUMECEL has a module for collecting the learners profile information. As the learner interacts with the e-learning environment, the following information is collected: user id, username, full names, email address, date of birth, course taking. The learner profile information is used for tracking the learner and delivering the required information and modeling the adaptivity based on the learner profile. This domain will be updated further with information from the feature extraction domain.

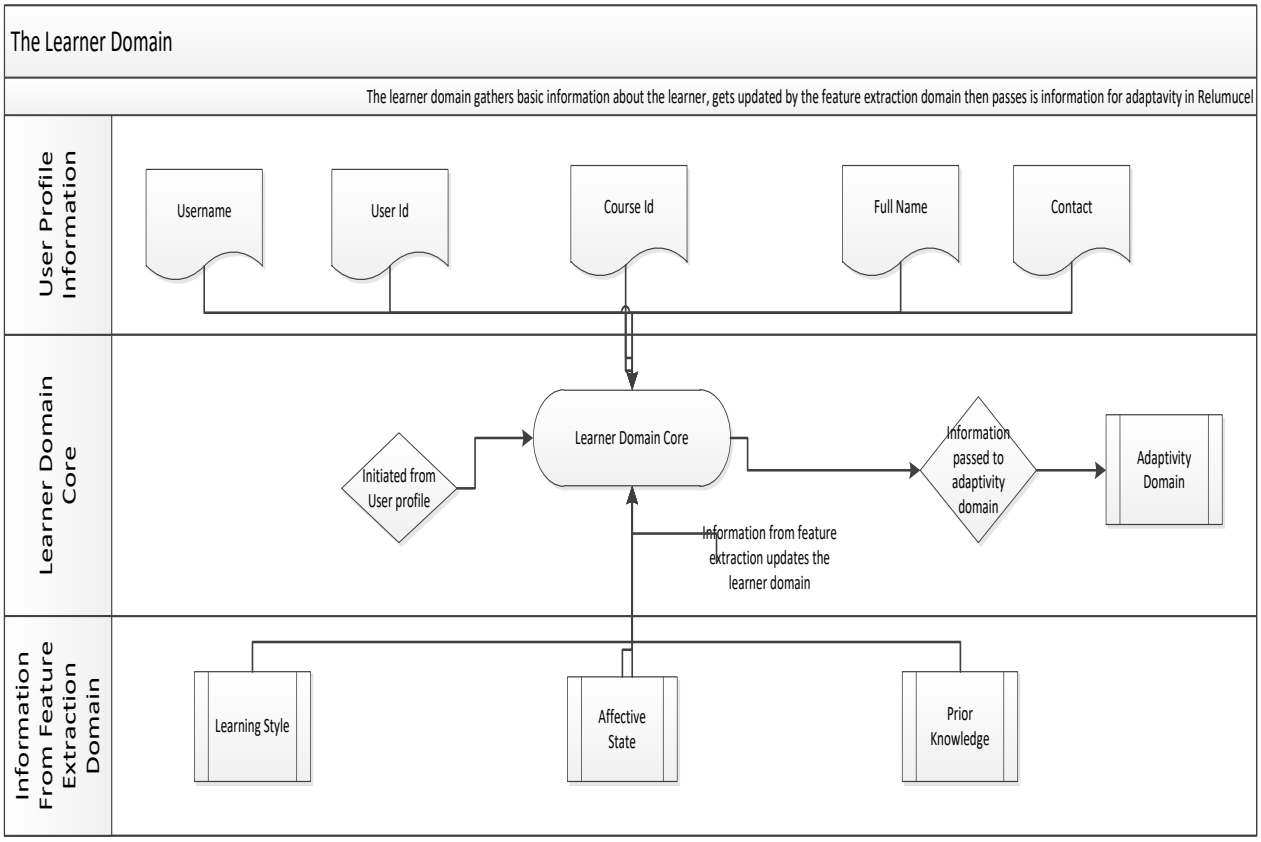

Figure 4. The learner domain

3.1.3 *The feature extraction domain*

Extraction of the learners learning style

The application of learning styles in e-learning environment setups, reinforces and enhances the learner's experiences by making the content retainable in the most effective and realistic manner and form. Implementation of learning style as learner characteristic in adaptive e-learning environment allows the acquisition of skills, knowledge and attitudes by the learner through the study or experience of the learner by their learning style preference.

We use the latest version of VARK questionnaire for the setup. VARK was developed Fleming. We use it to determine the Learning style of the learner. create a module and incorporate the questions of VARK in this module of the VARK questionnaire and its analysis responses as developed by VARK. The VARK questionnaire is incorporated in RELUMECEL as application module. The modules analyze the response of the learner and determines the learners learning style.

The figure below shows the application module with VARK Questionnaire.

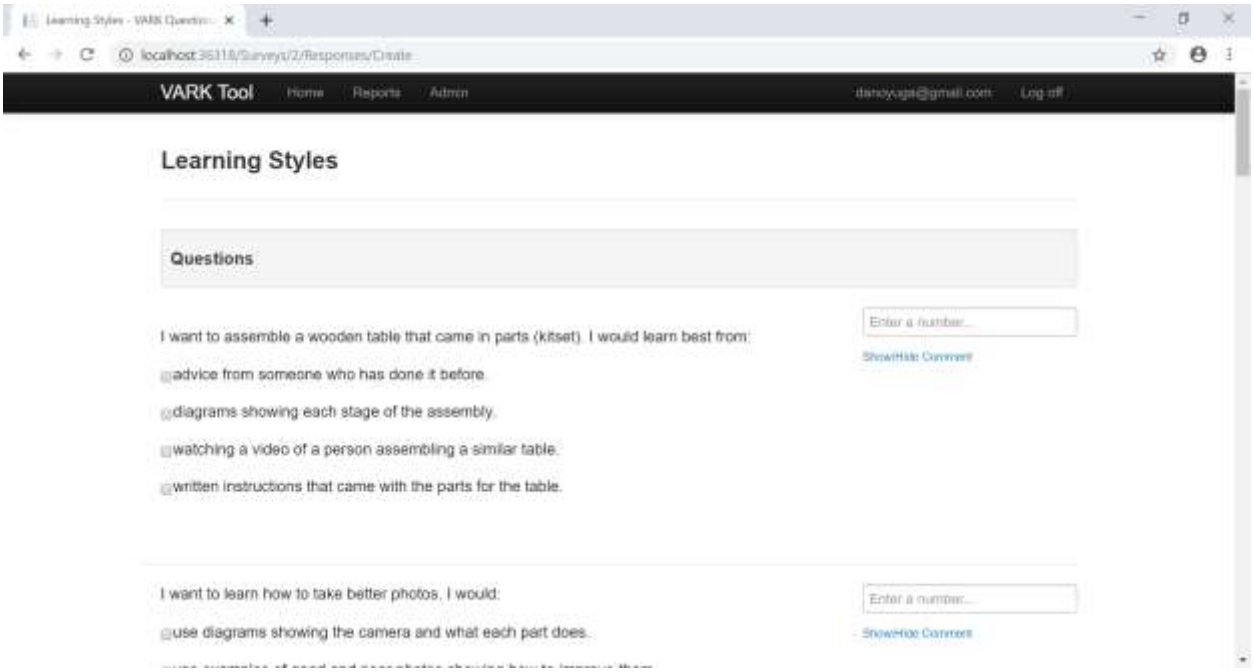

Figure 5. VARK questionnaire module

The learner at the initial interaction with the e-learning platform, is taken through the learning style module and answer the 16 questions depicted in the questionnaire as given by Fleming which basically asks the learner to reveal the way learner likes to learn. And with this the model will provide analysis of the given learner and give its learning style using VARK database developed by Fleming. The scores are used in RELUMECEL Engine to give further analysis together with the other learner characteristics

Affective states extraction

RELUMECEL focuses on, extraction of the affective state and "modelling the affective state." Modelling of the affective state is contextualized to the e-learning environment and the measure is in relation to various learning styles modelled. The extraction process is initiated by developing a model from existing natural language processing libraries, identification of the dataset to be used, preparing the dataset, dividing the dataset into training and test, identifying the best classification algorithms and finally experimenting with the best training algorithms for the best possible results. Once the model is built and tested its incorporated in the RELUMECEL environment so that it can be used for extraction of the learner affective state during his/her interaction with the e-learning environment

We used the ISEAR data which is an authentic for seven emotional attributes; fear, anger, disgust, joy.

The prior knowledge extraction

The measure of level of learner's knowledge in a particular field of study is very crucial in assisted adaptability for the learning path to be taken (van Riesen et al., 2018). Once the learner logs into the system and selects the subject and the topic he/she wants to take, he will be taken through the test questions of the subject, then he will be guided through to the next course of action and the outcome measured and the reward given based on the nature of the outcome.

The information resultant from the prior knowledge extraction process is kept as a log and fed into adaptation module to be used later for adaptability processing. The extraction of prior knowledge is further extended later; as later seen in adaptation module. It forms the basis of

determining a state a learner is at and the type of action he should proceed to take to gain maximum reward. It will also determine the where to explore more on the environment or just exploit learning by greedily picking on the next action to maximize on the rewards.

The Questions for prior knowledge extraction are based are aligned with the course being taken, learning objectives and other instruction design requirements that are in tandem with both learning theories and the learner characteristics being studied for adaptation.

3.1.4 *The adaptivity domain*

Once the RELUMECEL model has extracted information; learner's affective state, learning style and the prior knowledge, this is used as input to reinforcement learning model which is the core of adaptivity domain.

In Reinforcement learning, learning is a natural phenomenon that results from the interaction of an agent with its environment (Sutton, 2018). The environment domain consists of states and actions. The interaction of the agent with the environment is specific and strategic so as maximize some rewards apportioned during the learning process. Situations are mapped into actions similar to other forms of learning. In reinforcement learning, the argent/learner discovers the best action to take in any given situation within the parameters of the environment. The agent must proactively sense the environment, choose the best action in a given state within the environment among the available actions that maximizes the reward function. With the best action taken, the agent state is updated and it acquires a new state.

From Figure 7, we visualize a general reinforcement learning architecture. A given reinforcement learning environment has got features which defines it; State S, time t and state at a given time S_t . A given state has value which is dependent on immediate reward R at t giving R_t .

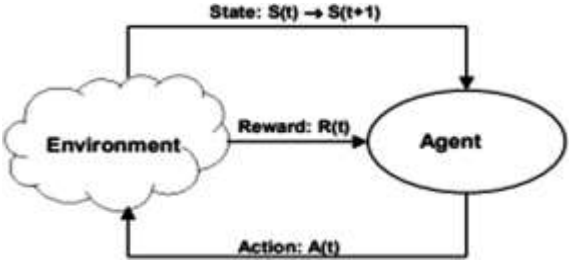

Figure 6. A reinforcement learning

To implement our reinforcement learning, we will explore the Q-learning algorithm.

Q-learning algorithm

According to Balasubramanian Velusamy (2013), Q-learning algorithm (Watkins, 1992) is model-free reinforcement learning that is focused in finding the optimal policy of a given Markov Decision Process (MDP). A Markov decision process is a 5-tuple (S , A , Pa , Ra , γ :) where

S is a finite set of states,

A is a finite set of actions or As is set of actions from s)

$$p(s', r|s, a) = \Pr\{S_{t+1} = s', R_{t+1} = r \,|S_t = s, A_t = a\}$$

is probability that action a in state s at time t will lead to state s′at time t + 1, in case of deterministic case we have $\delta(s_t, a_t) = s_{t+1}$, $R_a(s, s')$ is the expected immediate reward received after transitioning from state s to state s', due to action a, $\gamma \in [0,1)$ is the discount factor, which represents the difference in importance between future rewards and present rewards.

In a given [problem domain the agent strives to maximize the total reward as it transitions from one state to another. The Q-function which is a generalization of Q learning calculates the best combination of every state and action that will maximize the reward.

Q function will return a fixed value at start point of the processing, as it goes through the transition new values get computed as the agents rewarded and thus a Q-table is updated by these new values.

Q- function is denoted by

$$Q(s_t, a_t) \leftarrow Q(s_t, a_t) + \alpha\left[r_{t+1} + y \max_a Q(s_{t+1}, a) - Q(s_t, a_t)\right]$$

where

t – Present or Current state

t + 1 – the Next state

$Q(s_t, a_t)$ – the Q – values for the current state

R (St, at) – Reward after performing action at in St

α – The rate of learning ($0 \leq \alpha \leq 1$)

γ – Discount factor deciding the significance of the future and upcoming possible rewards ($0 \leq \alpha \leq 1$)

3.2 *Implementation and discussion*

The reinforcement learning architecture, begins with the learner's characteristics having been extracted from various modules of the model. These are stored as part of the learner logs which are used for various computations which inform reinforcement and hence learning path.

The lessons are designed and generated using a specific instruction model which aligns the lesson to the learning theories which addresses the specific characteristics and finally bringing out the adaptability. The learners with go through the guided learning process gets to attend the online lessons, do the assignments, tests and submits where necessary. The model detects the learner interactions and chooses for the learner the best paths, through actions at given times within specific states. This is done so that the learner can get maximum possible reward based on the state-action space. This is repeated in case the learner continually until a given best path is determine based on given learner combined learner characteristics measurements.

A learner visiting the system for a second or more time will have their information retrieved and the adaptability given. This will apply also to new learners with similarity in their learner characteristics

Table 4 below shows a lesson plan indicating module for topic "Object oriented programming using C++."

Table 4. The learning modules for a given lesson table

UNIT-One	Overview of C++:
Description	Object Oriented paradigms, Data abstraction/control abstraction, OOPS principles, Origin of C++, Sample C++ program, dynamic initialization of variables, new and delete operators, C++ keywords, General form of C++ program, Type casting, Introducing C++ classes, Difference between class and structure.
Assessment	T1-Exercise 1 T2- Exercise 2 T3- Exercise 3 Assignment 1
Expected from the student	

In this reinforcement learning model for adaptive e- learning, following the prescribed instruction model, states $s \epsilon S$ to be considered include taking Lessons, reading extra-material, solving exercises, going through questions and answers, waiting for answer, waiting for results, assignments, and assessments, Discussion, understanding and explanation. The actions $a \epsilon A$ to be considered include read/study, read more, study extra material, solve exercises, submit exercise, ask where doubt, perform tests, discuss, giving up, Questions and Answers, for more understanding then do assignment submission and finally complete the learning by exiting the system or logging out.

We assign the rewards values between 0 to ten and apportion the as in the algorithm below.

Begin

Do test

If performance>=3 and performance <=5

Provide with low level exercise

Else if performance>=6 and performance <=8

Provide with medium level exercise

Else if performance>=9 and performance <=10

Provide with high level exercise

Else if performance>=0 and performance <=2

Avail to extra learning materials to study

End if

end

Figure 7 below shows the representation.

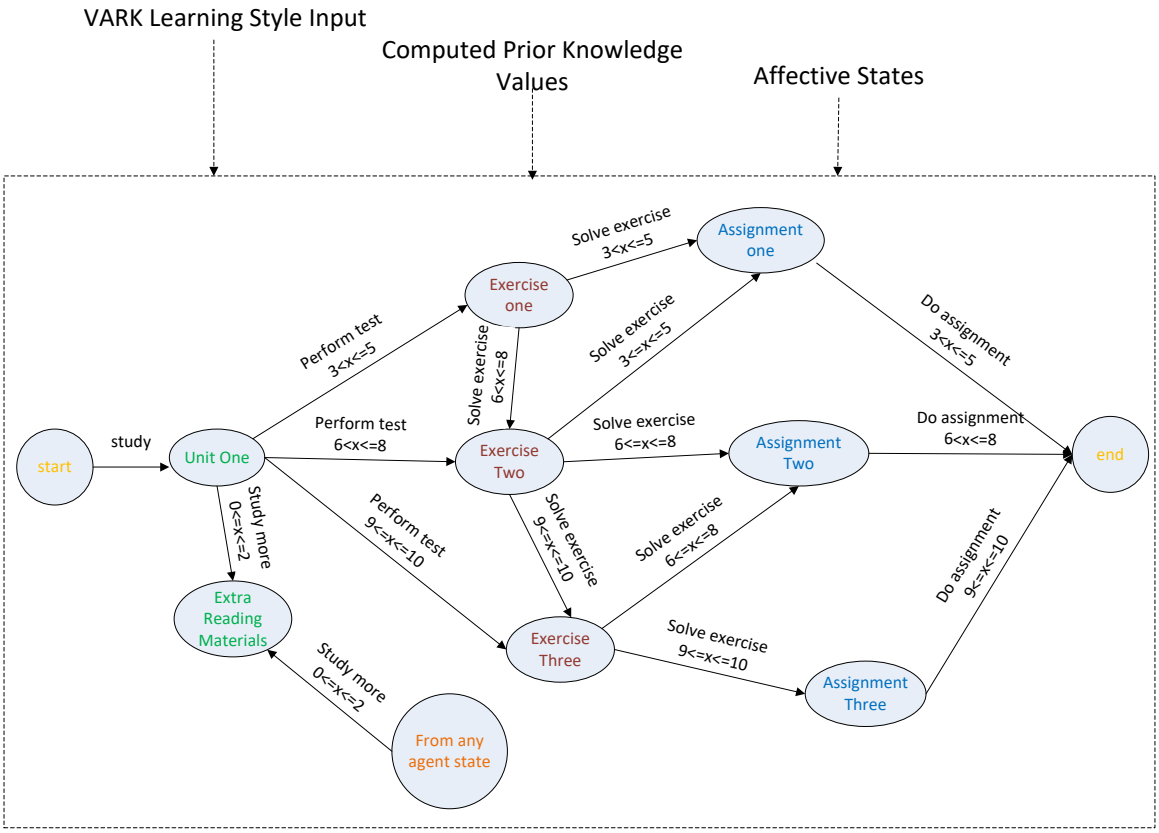

Figure 7. The diagram for state-action-reward of a single lesson

The content for e-learning is presented based on a given designer with the variables being, the title subtitles activities at each stage, timeline of each stage, the intended outcomes and the program structure. The planner assessment is based on ACM\IEEE curriculum recommendations. We built an instructional environment and resources which is dynamic and encompasses adaptability otherwise known as an adaptable instruction design based on environment and resources.

As a put out in Schott (2015), designing an instructional follows theoretical and practical research in the fields of cognition, education psychology and problem solving techniques. The strategies used in instruction design enhances the creation of guidelines for best practices in all aspects of the instruction process which include; planning and management of e-learning instruction method, delivery techniques, learner assessment and evaluation and feedback methods. The fundamentals of the theory are to produce measurable changes in learners' cognitive skills and attitudes. This calls for construction of lessons to achieve the intended objectives which then inform the creation of course plans.

There are a number of instruction models including analysis, design, development, implementation, and evaluation (ADDIE) model, ASSURE model, Dick And Carey Model, 4CD/ID model (Khalil & Elkhider, 2020). The models are formed to implement all or a at least one learning theory. Learning Theories (Cognitive & Processing, 2018) are defined as an organized set of principles explaining how individuals acquire, retain, and recall knowledge and they include Behaviorism, Cognitive Information Processing (Cognitivism) and Constructivism.

In this research the designer section explores ASSURE instruction model to design the dynamic courses and is keen on bringing out all the elements of Behaviorism learning theory.

The ASSURE Model can be seen below.

Figure 8. The ASSURE instructional model

As shown in Figure 8, ASSURE model is an acronym for the steps followed in the model; Analyze Learner Characteristics, State objectives, select/modify/Design Materials, utilize materials, Require Learner Response and Evaluation. In this research we are extracting multiple learner characteristics to give model e-learning environment and give adaptation to learners. ASSURE model is therefore ideal for our design purposes and as indicated by Sundayana et al. (2017) is well suited for Problem based and discovery learning.

Our environment states consist of lessons, exercises, assignments, assessments, exams and actions consists of, study, study extra materials, do assignments, perform test, submit assignments and others depending on the course composition. We have a wide state action space to be considered. We assume that the agent in this environment is also influence by the different learning characteristics of the learner/agent.

With the optimal policy calculated based on learner characteristics and given instruction design presented, and with the logs of learner profile, the model will then provide adaptability per learner based on learning characteristics of the learner.

4. Evaluations and experimental results

In using simulation of q-learning algorithm use simulation to get to help in varying the agent parameters especially the learning characteristics. Figure 5.1 shows the initial graph.

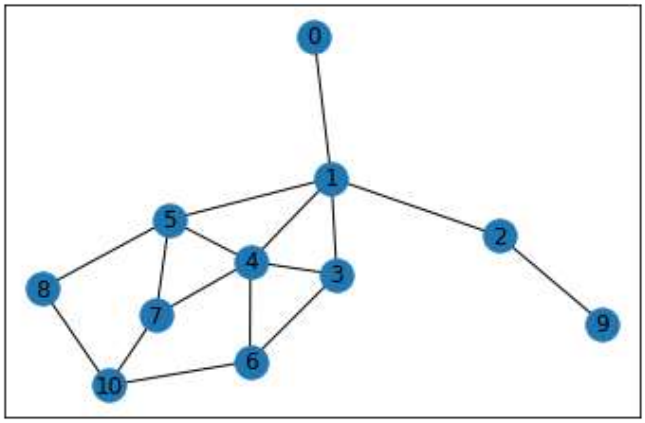

Figure 9. The environment network

We then defined the reward system which set at the maxim of 100 and if the learning takes place smoothly throughout the iterations, then Max reward is 100 as shown in the matrix generated in Figure 10. This Matrix is also the initial body of the initialized probabilities.

The initial matrix:

[[-1. 0. -1. -1. -1. -1. -1. -1. -1. -1. -1.]	[-1. -1. -1. 0. 0. -1. -1. -1. -1. -1. 100.]
[0. -1. 0. 0. 0. 0. -1. -1. -1. -1. -1.]	[-1. -1. -1. -1. 0. 0. -1. -1. -1. -1. 100.]
[-1. 0. -1. -1. -1. -1. -1. -1. -1. 0. -1.]	[-1. -1. -1. -1. -1. 0. -1. -1. -1. -1. 100.]
[-1. 0. -1. -1. 0. -1. 0. -1. -1. -1. -1.]	[-1. -1. 0. -1. -1. -1. -1. -1. -1. -1. -1.]
[-1. 0. -1. 0. -1. 0. 0. 0. -1. -1. -1.]	[-1. -1. -1. -1. -1. -1. 0. 0. 0. -1. 100.]]
[-1. 0. -1. -1. 0. -1. -1. 0. 0. -1. -1.]	

Figure 10.

With reinforcement value set at .75 we get matrix as shown and 1000 simulations of Iterations we are able to generate the matrix of the best learning path and provide determine the necessary reinforcement as shown in Figure 10.

Most efficient path:
[0, 1, 4, 7, 10]

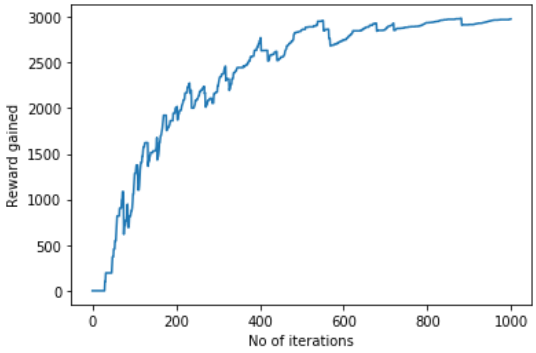

Figure 11.

Path with learning characteristics define

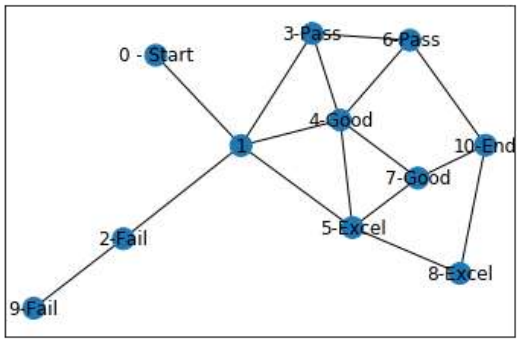

Figure 12.

The remaining are results of different simulations and the resultant matrix on varies possible paths.

Most efficient path:
[0, 1, 5, 8, 10]
Excellent Followed
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 25. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 18. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 23. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 32. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 47. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 21. 0. 0.]]

Figure 13.

Good Followed
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 19. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 22. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 15. 0. 0. 0.]
[0. 0. 0. 0. 0. 27. 0. 0. 26. 0. 0.]
[0. 0. 0. 0. 0. 36. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 32. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 23. 0. 0.]]

Figure 14.

Pass Followed
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 14. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 30. 0. 0. 0. 0.]
[0. 0. 0. 12. 0. 0. 19. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 27. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 18. 0. 0. 0. 0.]]

Figure 15.

Fail Followed
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 19. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 46. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 99. 0. 0. 0. 0. 0. 0. 0. 0.]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]]

Figure 16.

6. Conclusion and future work

This work presents enhanced approach to infusing adaptability to learning management systems by looking into three learning characteristics; learning style, prior knowledge and affective state. In this research we have created an adaptability based on learner characteristics and using reinforcement learning technology, we studied various processes which can be used to extract these characteristics.

We implemented reinforcement learning using Q-learning algorithm to bring out adaptability. We have not exhausted all the learner characteristics and therefore we propose that in future work the research can be extended to exhaust learner characteristics.

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A Literature Review on Automatic Generation of Examinations

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Abstract

The examination is a key activity in determining what the learner has gained from the study. Institutions of higher learning (IHL) perform this activity through various assessment methods (test/examination, practical, etc.). The world today is focused on automation of exam generation which is ongoing with dire need during this period of the COVID-19 pandemic when education is greatly affected, leading to embracing online learning and examination. A text/exam comprises questions and answers that focus on evaluation to determine the student's conversant level in the area of study. Each question has a cognitive level as described by (Armstrong, 2016) in the revised Bloom's taxonomy. Questions chosen have cognitive levels based on the level of study and standardization of the exam. There is, therefore, a need to consider the question's cognitive level along with other factors when generating an examination by incorporating deep learning algorithms.

Keywords: natural language processing, MLA – machine learning algorithm, AI – artificial intelligence.

1. Introduction

Over time, there has been a notable increase in the number of students joining tertiary institutions. To manage the increase, institutions have responded by creating flexible learning patterns including introducing e-learning and embracing technology in digitizing the majority of the work involved. Automation has been adopted to enhance efficiency and effectiveness at a reduced timeframe. Flexible learning pattern calls for flexible examination pattern thus examiners are challenged to re-think an approach to cater to this need. The solution is to semi or fully automate the examination process to minimize human intervention and increase efficiency and effectiveness.

There has been a challenge in developing the examinations as questions and answers are not readily generated. Researchers have indulged in the automatic questions generation with the majority focusing on the multiple-choice questions and "wh" questions as demonstrated by

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(Ali et al., 2018). Question cognitive level, weight, and topic coverage are key factors to consider when setting exams. Most of the researchers focused on vocabulary assessment and understanding while few studies check question complexity based on the complete spectrum of Bloom's taxonomy. Little has been done on the use of Bloom's taxonomy in exam generation.

2. Methodology

This study is constrained to the classification of questions for generation of examinations purposes.

2.1 *Research questions*

1. What are the processes involved when setting examination?
2. What technologies have been utilized to automate examination generation?
3. What machine learning algorithms have been used in questions classification?
4. How can artificial intelligence be incorporated in question classification to better examination generation?

2.2 *Data sources*

Four sources of data have been considered: IEEE, Science Direct, Google Scholar, and Springer.

Out of the 475 documents that were sourced, 184 were considered most relevant. A query criterion "Automatic or automated generation of Examinations or test or exam or questions classification." This search was done from December 2019 to June 2021. It was made flexible to accommodate many items. The summary of results is as below:

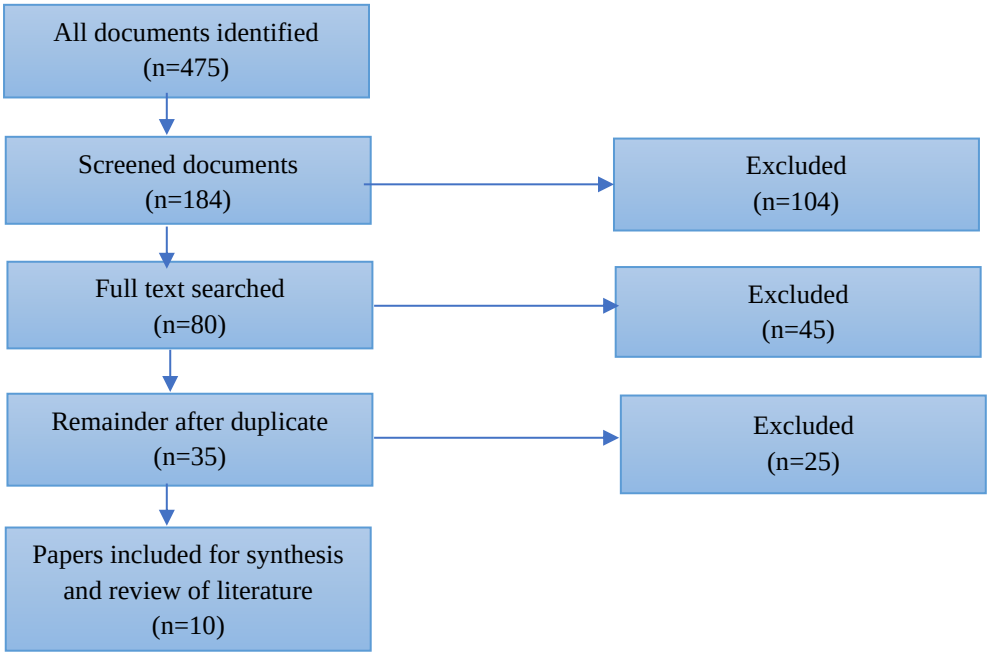

Figure 1. Summary of the query criteria

3. Examinations and test papers

3.1 *Standard examination*

There are many types of assessment or "testing" to access student's learning curves, however, the written examination is the most common approach used by any higher education institution for students' assessment (Omar et al., 2012). An exam contains questions that some studies have sought to classify exam based on Bloom's taxonomy (Abduljabbar & Omar, 2015). In recent times, there have been attempts to classify the questions using Bloom's taxonomy by various researchers using diverse methods. The question cognitive level has been determined using techniques like machine learning, role-based approach among others.

IHL offers studies in one or more levels of study ranging from hands-on skills to professional programs. A question can be examined at various levels of study to test learning. There is, therefore, a need to analyze exam questions to fulfill the requirements by different levels of education such as Bachelor's degree or Master's level (Mohammedid & Omar, 2020).

Content validity, scorer reliability, discrimination, and objectivity are the four principles identified by Johnson (2001) that constitute a standard examination. **Content validity** is representative coverage of the whole course. **Scorer reliability** directs that if the script is subjected to two different examiners, they should arrive at the same score, i.e. there shouldn't be a significant statistical difference in score. There should be a way to differentiate the achievers and weak students to avoid **discrimination**. **Objectivity** prescribes that the test should be fair to all irrespective of age, gender, religion, or any other natural distinction. Examiners should ensure that the test to students in the same level or class test similar concepts and are sensitive to questions cognitive levels to enforce the Objectivity demand.

3.2 *Exam questions*

Questions bear different difficulty levels (Krathwohl, 2002). The difficulty levels build in increasing order from basic, rote memorization to higher (more difficult and sophisticated) levels of critical thinking skills. Therefore, question cognitive levels must be put into consideration during examination generation to facilitate standardization. Failure to consider this may lead to an imbalanced test, i.e., containing many sophisticated questions making it hard for the students or vice versa.

4. A revision of Bloom's taxonomy

Bloom's taxonomy revised edition by (Krathwohl, 2002), breaks the cognitive domain into six levels:

(a) *Remember* – This level entails remembering what is learned.

(b) *Understand* – It is the ability to interpret and comprehend in such a way that one can state the problem in their own words.

(c) *Apply* – Ability to use the concept to solve a new problem.

(d) *Analyze* – This is critically breaking down of information into parts guided by motives or causes and developing inferences that support generalizations.

(e) *Synthesis* – This is the ability to come up with something new by putting information together in a special manner or proposing alternative methods.

(f) *Evaluate* – This is the ability to develop justification and defending an opinion by making judgement about information, the validity of ideas, or the quality of work based on a set of criteria.

5. Review of literature

5.1 *Setting examination*

This is the process of preparing questions to use in assessing the concept taught (Ogula et al., 2006). Ogula is of the view that all the processes of setting exams should be made internally. The processes involved in setting exams are exam setting, moderation, vetting by the external examiner, printing, and proofreading. All these processes consume valuable time and at times may subject exams to leakages if mishandled.

A quality exam should factor in the six Bloom's cognitive domains of knowledge (Bloom, 1994); knowledge, comprehension, application, analysis, synthesis, and evaluation. An exam consists of two sections, the questions' part, and the part of the answer. Questions have properties like mark(s), topic, and complexity (cognitive level). Marks are assigned to each question and determine the weight of the question in the exam. This assignment is influenced by the level of study and the question's complexity. A question examines an area of study (topic) and its complexity indicates the cognitive level. A question can be classified as very simple, simple, moderate, hard, or very hard. Each question should aim to test a certain cognitive level as described in the revised Bloom's taxonomy.

5.2 *Automation techniques in questions classification*

The issue of classifying exam questions based on Bloom's taxonomy has received considerable critical attention in recent years. To handle this task, researchers use different techniques and features (Omar et al., 2012). In this study, MLA and NLP are used. The machine learning algorithms used are K-Nearest Neighbors (KNN), Logistic Regression (LR), and Support Vector Machine (SVM). The study aimed to combine two features: word2vec and TFPOS-IDF (W2VTFPOS-IDF).

Verbs and actions were used to demonstrate different levels of learning (Diab & Sartawi, 2017). The solution was based on the classification of the action verb of the questions or learning outcome statement (LOS), to classify the whole question or LOS into a more accurate level. Action verb classification algorithm was applied on the verb lists from questions and LOS to compute the maximum similarity for every level of the cognitive domain. A rules-based approach was used. The study was concluded by the finding that the approach can be used to provide more accurate verbs and in turn, provide more accurate intended mental skills.

A document analysis method was used by (Karamustafaoglu et al., 2011). The research noted that teachers were asking many questions at the first three levels of Bloom's taxonomy. This study indicated that most teachers fear that the student may not pass the test and therefore resolve to set questions on the low cognitive levels. It concludes by recommending consideration to the questions at the higher cognitive levels to facilitate critical thinking. Surface learning is entertained by assessment strategies that reward low-level outcomes (Buick, 2011).

A comparative study of SVM and K-NN was done by (Patil & Shreyas, 2018) in an attempt to achieve better performance and high quality. Grammar and context checks were applied. The classification was used to test the student level and skills gained compared to Bloom's taxonomy cognitive levels.

Support Vector Machines (SVM) algorithm was used by (Yahya et al., 2012). The classification algorithm was divided into three steps; text representation, SVMs classifiers construction, and SVMs classifiers evaluation. This technique was evaluated by varying the frequency of stop words. The research observed that an increase in the number of words used to represent the question lowers the performance of SVM. It concluded that the number of stop

words should be more than one for a good performance and that reducing the number of stop words does not significantly improve performance.

5.3 *Automation techniques in exam generation*

Computer technology is rapidly changing. This has, therefore, contributed to the development of ideas and algorithms. A computer system can be made to simulate the process of generating exams. Such a system needs to coherently accommodate the discussed items to successfully examine learning. They include; cognitive level, topic, and weight/mark(s).

Despite the need to automate the process of exam generation in institutions, the success of the system must always fulfill certain parameters. Approach, tools, and algorithms used in the development phase play a significant role in fulfilling the addressed need. The quality of E-Systems is determined by views and usages (Nabil et al., 2011).

The question bank is the storage area for the questions fed into the system. Filtering criteria may be adopted which include; exam paper generation process, exclude/include past semester, the total number of items per paper, item complexity, maximum items per topic, paper topic settings, test paper generation, items analysis as described by (Yusof et al., 2017).

An automated paper generation system done by (Bhirangi & Bhoir, 2016) focused on controlled access, questions randomization, and user roles. The use of the cognitive level is not clearly outlined. The software was developed using Java programming language and MySQL database for storage. The algorithm used is improved on the randomization of questions.

Artificial intelligence, randomization, and backtracking are the algorithms used by (Cen et al., 2010) in their project to automate the exam generation process. Technologies used in this system are the MVC pattern in JSP view, JavaBean models, the Servlet Controller, MySQL, CSS + DIV for layout, and JavaScript. Cognitive level and questions weight are not addressed. JSP and Java Servlets are being replaced by emerging technologies. The system produces a word document that can be edited and sometimes loses layout due to compatibility issues.

The cognitive level is used by (Joshi et al., n.d.) in their e-system. Two algorithms; random selection and backtracking, are used. The use of artificial intelligence is not clear. The weight of the questions is computed as a percentage.

Generation of examination should indulge in the use of Natural Language Processing (NLP) as recommended by (Joshi et al., n.d.). This would focus on understanding the question's cognitive levels and prevent a question from being used most frequently.

Package exams developed by (Grun & Zeileis, 2009), provides software infrastructure for scalable exams, associated self-study materials, and joint development. The software used maintenance, variation, and correction as design principles. Technologies used are Latex and R. Questions were separated into answers and solutions sections. Some meta information is collected. Question and a solution description are encapsulated in Latex. In this approach every exercise is contained in a separate sweave file, therefore you need separate files for each. This method was used to make a custom application for processing statistical exams.

Natural Language Processing is used to process text and Named Entity Recognizer and Semantic Role Labeler are used to identify the semantic relation (Rakangor & Ghodasara, 2015). The main focus was to generate simple questions that are true or false or require a one-word answer.

An online system by (Hameed & Abdullatif, 2017) utilized web-based technologies; PHP, MySQL database. Three types of questions were taken into consideration which is true/false,

multiple choices, and image matching. This system did not factor in artificial intelligence, cognitive level, or even question weight.

A rule-based classification approach was used to classify exams by (Kumara et al., 2019; Kumara, Brahmana & Paik, 2019). The model established enabled adjustment of the paper quantitatively. Though the model worked to classify the questions using cognitive levels the research concluded by recommending the introduction of machine learning techniques to increase performance.

6. Conclusion

Examination plays a key role in evaluating what the student has learned and requires to be performed with high precision. Examiners should come up with questions that are sensitive to the cognitive levels outlined by Bloom's taxonomy to ensure that the levels form part of consideration during exam generation. The process of questions classification can be automated by utilizing advancement in technology that presents the world with techniques in AI specifically ML and NLP. A combination of these technologies is resourceful in predicting the question's cognitive levels and realization of a standard examination.

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The authors declare no competing interests.

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Intelligent Conversational Agent for Enhancement of Online Communication in Universities: An Overview of Kenyatta University

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Abstract

University websites and online portals are the primary means through which potential students and other stakeholders find important information about an institution. University websites are essential to these organizations' marketing and communication efforts. In this paper, focus has been put on the need to complement these websites with the use of an AI Chatbot (UniBot) in order to serve more efficiently. This study aims at performing an extensive literature survey on intelligent conversational agents and the feasibility of applying them in enhancing online communication in universities. The study utilizes an iterative – incremental methodology to aid in design and development of UniBot, using AIML (Artificial Intelligent Markup Language) Pattern matching algorithm on the Pandorabot (AIAAS) platform, to generate high quality training data, with which, the agents Natural Language Understanding (NLU) model is trained. The study also provides for training and testing the agent using data which is acquired from Online Communication, University Website department at Kenyatta University.

Keywords: artificial intelligent markup language, AI Chatbot, natural language understanding.

1. Introduction

According to Melisa Perich (2015), a lot of research work has been done on Artificially Intelligent Systems to support education. Elis, Allen and Tuson (2010) argue that with the development of Artificial Intelligence, computer systems can complete or perform tasks that would require human intelligence at a much larger scale than we could on our own. AI has been applied in fields like speech recognition, visual perception, natural language processing and decision making. Artificially Intelligent Conversational Agents or Chatbots have being utilized in a number of ways. Companies like Paypal, Facebook and Tesla are increasingly relying on Artificially Intelligent Bots. Google has also developed Google Assistant which is a virtual agent that can engage users in two-way conversations. From these advancements we can clearly see that there is a growth in Artificially Intelligent Conversational Agents or Chatbots adoption rate. Modern commercial chatbots offer more advanced development environments enabling the design and development of intelligent conversational agents with complex and goal driven behavior.

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2. Literature review

The development of conversational agents enabled human beings to interact with computers by use of natural language processing (NLP). According to Atwell and Shawar, (2007), with the growth in pervasive computing and technologies, there developed an ardent requirement to interact with computers in the same way communication is done with people, by using natural language. According to (Zadrozny et al. 2000), by allowing users to express themselves directly and in a natural way, i.e., by speaking, typing, and pointing, a more sophisticated HCI can be achieved. Milan Van Eeuwen (2016) defines a chatbot as an overall term for describing concepts like chatter bots, virtual agents, and conversational agents. Desaulniers (2016) defined a chatbots as an interactive messaging application powered by artificial intelligence (AI). In addition to Desaulniers definition, Schlicht (2016) describes a chatbot as a service, powered by rules and sometimes artificial intelligence that you interact with using a chat interface. A chatbot is defined in various ways but they all describe the same phenomenon. The definitions mostly differ in mentioning to what extent a chatbot is driven by artificial intelligence. With more progress in research, Milan van Eeuwen (2017) describes a chatbot as an intelligent application that interacts with user in natural language through a chat and can be used effectively to serve a commercial purpose. According to microsoft.com (2018), Microsoft Cortana has some services like weather forecast, calendars, reading outlook emails, giving time estimations for travel, giving directions, and integrating with OneNote to show users' their notes. According to Google Assistant (2018), Google Assistant is an extension of the basic OK Google functionality that allows users to conduct search and control their mobile devices through voice commands. Assistant is programmed into Google phones, Android OS and will be integrated into some cars. According to amazon.com (2018) (retrieved from https://developer.amazon.com/alexa), Alexa can access the weather, connect to radio and television stations, and has partnerships with a number of services, including: JustEat, Uber, FitBit, The Telegraph, Spotify and Nest, among others. These services can be accessed with the Alexa interface.

3. Evaluation and results

3.1 *Approach*

Black-box approach which is qualitative assessment was chosen to evaluate UniBot. Black-box approach focuses on the output generated in response to the given input without concern with the internal processing. This approach suits the nature of UniBot well because the core function of UniBot is to deliver appropriate answers to users in real time in order to overcome some of the problems associated with the current online communication systems as stated in Chapter 1. Black-box approach has been used by other researchers in question-answering system whether in open domain (Nyberg & Mitamura, 2002) or restricted domain (Diekema et al., 2004) as well as for conversational bots (Goh et al., 2007; Preez et al., 2009). Turing test which has high regard in this field is also a black-box approach (Floridi, 2003).

3.2 *Dataset*

Datasets are required to examine the responses generated by UniBot in black-box evaluation. For this purpose, one hundred questions are used.

3.3 *Dataset's results*

From the results shown in Table1, Uni-bot was accurately able to score 47 points out of 100 points. The scores are grouped according to the frequency so that trend can be observed in Table 5.5 and Figure 1.

Table 1. Frequency of points

Point(s)	Frequency	Percentage (%)
4-Point	47	47
3-Point	20	20
2-Point	12	12
1-Point	16	16
0-Point	5	5
Total	100	100

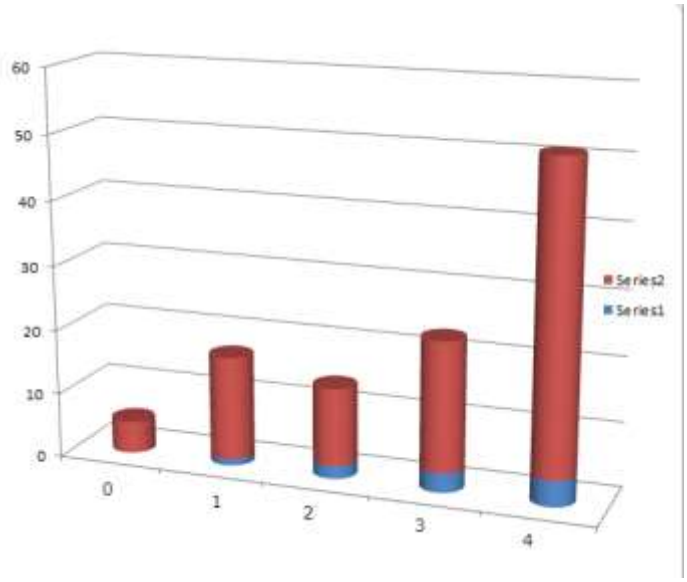

Figure 1. Scores frequency chart

From the table and chart shown in Table 1 and Figure 1 respectively, it can be seen that the majority of the dataset results fall at 4-point score. This means that Uni-bot was able to provide correct answers at most of the time during the test and some even with creative answers. Out of the hundred questions, 5 percent of the answers are in categories of 0-point to 2-point. This shows that Uni-bot was able to response appropriately by at least giving some relevant answers. However, the existence of 0-point results means that there are still some questions ended up with completely irrelevant responses. In this case, Uni-bot still needs to be further improved in the future.

3.4 *Summary*

This chapter saw the evaluation of UniBot being conducted using one hundred datasets compiled from online chat communication logs from KU Online Communication Department. The evaluation is done using the black-box approach which completely relied on the outputs generated and in this case are UniBot's responses. From the results gathered, it can be seen that UniBot was able to provide correct answers at most of the time and only small percentage of 5 percent having unrelated responses.

In terms of the objectives of this project, the evaluation showed that UniBot demonstrated the success of achieving the three objectives stated in Chapter 1.

3.5 *Conclusion*

This research has demonstrated a conversational agent for a university website users implemented using AIML. The evaluation results have shown that UniBot has great potential to interact with end users. Even though the knowledge in this study is limited to a single university, the solutions is customizable to fit any university setting. The advantages of UniBot such as being able to provide 24-hour service that can serve different time zones, able to have knowledge in multiple domains, and one conversational bot can be shared by multiple sites simultaneously have outweighed its existing limitations which are mainly due to external factors.

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