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Issues and Implications of Library Networking

Senthur Velmurugan

Bharathiar University, Kongu Arts and Science College, Erode, INDIA

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Abstract

Library Network alludes to an interconnected foundation of some gathering of libraries with specific arrangements intends to fulfill and satisfy their clients' needs. Every library performs the sharing of assets to every other on request premise. A library network is a group or co-employable movement of connecting. Individuals/clients to the assets facilitated on PCs by methods for media transmission associations. An organization comprises of at least two PCs that are connected to share assets, (for example, printers and CDs), trade records, or permit electronic interchanges. Two regular kinds of organizations include: Local Area Network (LAN), and Wide Area Network (WAN). Switches and remote passages are the fundamental systems administration nuts and bolts. Through them, gadgets associated with your organization can speak with each other and with different organizations, similar to the Internet. Switches and remote passages perform altogether different capacities in an organization.

Keywords: networks, types of networks, importance, issues, and implication of networks.

1. Introduction

The organization is the term that is generally used to interface PCs that impart assets and data to one another through some sort of medium. Systems administration of libraries a co-usable undertaking of libraries, improves different regions, for example, inventorying measure, information base creation, and staff advancement as well. Presently data has gotten a basic for our everyday exercises. As indicated by Seetharama (1997), the time has come, that data experts understand that arrangement of admittance to data as more significant than assortment building. Subsequently, a need has ascended to find some kind of harmony between nearby proprietorship and organization access which ought to be reflected in the assortment improvement strategy proclamation.

Correspondence: Senthur Velmurugan, Bharathiar University, Kongu Arts and Science College, Erode, INDIA.

2. Networking definition

The expression "systems administration" or organization is utilized in various settings. Data network has gotten mainstream and is utilized oftentimes by data pros. An organization is characterized by the National Commission on Libraries and Information Science (NCLIS), USA, as "at least two libraries or potentially different associations occupied with a typical example of data trade, through interchanges, for some useful reason." Alphonse F. Trezza (in Wedgeworth, 1993) characterizes network as "a conventional association among libraries for co-activity and sharing of assets, in which the gathering all in all is composed into subgroups with the exemption that the majority of the requirements of a library will be fulfilled inside the subgroups of which it is a part." So, an organization has been utilized to mean a conventional association or gathering of libraries and data focuses following some regular example or plan for data trade and correspondence to improve proficiency.

3. Advantages of network-based library services

1. Library network offers great potential and new areas of sharing information among different libraries.

2. On-line access to information and reservation is possible without physically coming to the library.

4. Types of networks

There are two sorts of organizations (Durgadevi & Usha, 1998):

1. PC network Computer network is worried about the sharing of the PC burden, programming, and equipment, and PC time.

2. The correspondence organization. Correspondence network is essentially worried about information transmission. These organizations can convey a lot of information over significant distances. While arranging an organization, the expenses of establishment and access ought to be considered.

The Local Area Network (LAN) alludes to connecting workstations inside a solitary structure, though a Wide Area Network (WAN) joins workstations together which might be in closeness. New and esteem included administrations, for example, phone messages, electronic mail, video text, telephone utilities, and so on offer more for the ideal usage of the organization. The web is an excellent case of an organization that encourages the determination and obtainment of data materials, record conveyance, and access electronic diaries and specific materials.

5. Aims and objectives of library networks

As we have seen before, the fundamental reason for making an organization is to give data administrations to part libraries through the sharing of assets of the partaking libraries of the organization. This may prompt part libraries to rely more upon admittance to reports held in the other part libraries than on relying just upon their particular assortment.

The primary points and destinations of the library network are expressed as the accompanying (n.d.2):

(i) To advance asset sharing and co-activity exercises among libraries by giving effective and solid methods for asset sharing.

(ii) To improve asset use and administration level at the individual libraries by giving computerization offices

(iii) To organize endeavors for appropriate assortment improvement and diminish superfluous duplication at every possible opportunity.

(iv) To build up referral focuses to screen and encourage inventory look and keep up a focal on-line association index of books, serials, and non-book materials of the apparent multitude of taking an interesting library.

(v) To build up a master bibliographic information base of books, serials, and non-book materials for search and access.

(vi) To make a data set of tasks, pros, and establishments for giving on the web data administrations.

(vii) To facilitate with other local, public, and worldwide organizations for the trade of data and records for the utilization of libraries and clients.

6. Importance of networks in library

Allen Kent (1978) has communicated that the achievement and endurance of library and Information Centers will rely upon how a lot and what degree libraries help out one another in the future. The expanding expenses of data source materials, expanding cost of preparing archives and their data substance, diminishing financial plans and wide utilization of miniature and smaller than normal PCs have added to the advancement of organizations.

Chaudhry (1996) has featured the significance and handiness of organizations and systems administration as "Organization data assets, as augmentations of library assortments and as bibliographic and correspondences utilities with their uncommon network, speed of transmission and overall expansiveness have made incredible open doors for libraries. They are rethinking the idea of the assortment and assortment advancement and changing the choice, safeguarding, correspondence, and contact capacities in libraries, making a ground-breaking new challenge for the hypothesis and practice of assortment the executives, and expecting bookkeepers to grow new abilities, acknowledge new duties and change their methods of performing different library activities."

7. Issues of library networking

Library Networks help us in the spread of data in an agreeable way where all the concerned libraries pool their assets, and use them, accordingly guaranteeing the ideal use of assets. However, behind setting up a library arrange and use its administrations, there is many issues confronting the Library/Information experts. Some ongoing examinations have demonstrated the accompanying as serious issues to be thought of:

1. Status of libraries;
2. Absence of instruction and preparing;
3. Specialized and preparing offices issue;
4. Absence of money;
5. Issues at the focus;
6. Programming issues, language issues in shared indexing frameworks, information base plan issues, and so on;

7. Similarity among frameworks/information bases;

8. Issues with normalization;

9. Issues in procuring data from global bury government associations;

10. Issues while looking on-line;

11. Free advancement of significant organizations.

8. Implications of networking

The ramifications of Resource Sharing Networks can be sorted into five kinds. They relate to staff, exercises, cost, innovation, and time (n.d.1):

1. Suggestions relating to Staff;

2. Suggestions relating to exercises in Libraries;

3. Suggestions relating to Cost;

4. Suggestions relating to Time;

5. Suggestions relating to Technology.

9. Conclusion

Indian libraries are not adequate produced for library organizing. Yet, we can get the advantage of creating nations in this field. Standards and practice both are significant. So library organizing is reformist to fulfill users' need at a lower cost.

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Design and Implementation of an Edutainment Games Application for Kindergarten Kids

Victor Adebola Omopariola[1], Monday J. Abdullahi[2], Raphael Ozighor Enihe[1] & Chukwudi Nnanna Ogbonna[1]

(1) *Veritas University, Abuja, NIGERIA*
Department of Computer and Information Technology

(2) *Airforce Institute of Technology, Kaduna, NIGERIA*

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Abstract

Edutainment is a worldwide known concept, adopted by many countries for its educational uses and studied in various forms, unfortunately less explored in the teaching learning space due to other priorities regarding education. The lack of case studies related to this concept in the educational space brings the opportunity to adapt the concept to the needs of preschoolers and teachers. Technology became a part of everyday life, and its usage should be oriented to the benefit of the next generations. This paper is a report of introducing an edutainment application into the formal kindergarten system. The implication of this paper is to provide the design and implementation of an edutainment games application for Kindergarten kids. During the last decade, there has been an explosive increase in the number of mobile apps that are called educational and target children aged three to six. Research has shown that only a few of them have been created taking into consideration young children's development and learning processes. The key question that emerges is how parents, custodians, or teachers can choose appropriate, high-quality educational apps.

Keywords: mobile educational applications (apps), smart mobile devices, kindergarten children, parents, edutainment, education.

1. Introduction

1.1 *Background of study*

Educational system has faced several reforms along the last twenty-eight years regarding curriculum, forms of organization, redefining the ideal of education according to the EU requirements. It is organized in three stages: preschool stage (children aged 3 to 6), school stage, children aged 6/7 to 18-primary, secondary and high school) and university stage (Moldovan, 2019).

Only primary and secondary school are compulsory for the moment, but further legislation in the area states that preschool stage will become as well. Political, social, and economic development following the transition from dictatorship to democracy came with mandatory changes regarding education. Along the way, measures taken were meant to improve the teaching-learning process and get better results at national exams and international contests,

Correspondence: Adebola Victor Omopariola, Veritas University, Faculty of Natural and Applied Science, Department of Computer and Information Technology, Abuja, NIGERIA.

as well as developing competencies and skills needed to integrate youngsters in different work fields. Thus, the need to have digital skills formed from early ages, preschool stage, even earlier (Moldovan, 2019).

It started with preparing teachers, giving them the possibility to participate to special courses in order to achieve certain digital competencies, promoting e-learning, continued with introducing computers, useful devices and internet in schools in order to provide resources to improve, ease and increase the benefits of education. It continued with preparing children, an ongoing process that needs a special attention. Using technology in teaching and teaching children how to learn using it seems to be the challenge of the 21st century in Nigeria.

Preschool stage, kindergarten time is dominated by discovering the world through games and playing. This stage is the proper start in making acquaintance with using devices in a joyful and pleasant way, making a transition from listening to a song or a story, to pressing a button to listen to them, to interact according to rules and pay attention to the process of interacting. This brought the idea of building applications to serve the teaching environment as well as the learning process and cover the entertainment side of the process (Piaget, 2017).

As Techopedia states, Edutainment is a portmanteau of the words education and entertainment that refers to technologies and software products which combine education with entertainment in some way. In the digital age, many of these products and technologies seek to make education more attractive to young people and students. Edutainment technology comes in many forms. A streaming video platform or a prepackaged learning product can be categorized as edutainment if it has both entertainment and educational value. Edutainment is very much an issue in developing modern digital and hybrid curriculum for the classroom, and for supplementary educational use (Rapeepisarn, 2019).

Recent studies and research show a great interest in involving several institutions in the process of developing digital teaching-learning materials, as a partnership between university and school, with students building lessons for a computing school and visible results in classroom. In the next section, the introduction of edutainment applications in kindergarten will be described from the perspective of a process providing content, co-design and actual teaching based on them (Kharuffa, 2019).

1.2 *Statement of the problem*

Basic number concepts applied in kindergarten classroom to set the foundation for learning more advanced math concepts in future. Early exposure to math and number activities will make children more comfortable with the skills. If the children are not comfortable with math and number concepts at a young age, they will be lack of confidence in their abilities and may lead to hesitation when more advanced math concepts are introduced. When this problem happens, they may start believing that they are not good in math and will have risks beginning a self-fulfilling cycle of failure.

To solve this issue, Edutainment game mobile application has been introduced as an alternative to help the children to learn basic numbers in an easy way. Math learning is most exciting for children when hands-on manipulatives are combined. Manipulatives give children physical illustrations of the numbers and counting concepts. However, children will also easily feel bored if the teachers using the same and traditional way to apply in their teaching. Therefore, the introduction of the electronic-based educational game will be a great solution to help the teachers to teach math in a fun and easy way so that the children can have additional opportunities to practice these skills, yet it will increase their confidence when working with math and number concepts.

1.3 *Research questions*

1. Can a better structure be implemented in teaching kindergarten students?
2. How can an edutainment game application teach kindergarten students?
3. What are the problems that affect the current way of teaching kindergarten kids?
4. What are the benefits of edutainment game application?
5. What are the requirements needed for developing an edutainment games application for kindergarten kids?

1.4 *Research objectives*

This study aims to develop a new system to improve the current way of teaching kindergarten kids in the form of game to increase their learning approach.

The following are the objectives of this research:

1. To answer the research questions in the course of the entirety of the rest of this project.
2. To design an efficient edutainment game application.
3. To implement the edutainment mobile application.
4. To evaluate the performance of the proposed system.

1.5 *Scope of study*

The focus of this project will be mainly on development of an edutainment game application for teaching kindergarten children basic number through game using mobile app. Moreover, this project also studies and compare between the effectiveness of learning basic numbers through game using educational game board and with the manual teaching. The software implementation of the design is using Android studio IDE. Android Studio IDE is used for designing and developing mobile apps.

1.6 *Significance of study*

With the rapid development of computer technology in all fields of operation high demand for e-learning, it has become a necessity to develop an edutainment games application to teach kindergarten kids more effectively:

1. Kindergarten kids would enjoy the learning process.
2. Make it easier for kids to easily adapt to the digital world.

The outcome of this work would be beneficial to a lot of institutions. This work is intended to implement various software and automation processes for an edutainment game application. By doing so, it is hoped that it would establish a broader understanding of the edutainment game application in order to automate or add additional improvements to such systems successfully.

1.7 *Organization of the project*

This chapter contains introduction, Chapter 2 explains the Literature review for the chosen project. Chapter 3 explains the design methodology. Chapter 4 covers the implementation and documentation of the proposed project. Chapter 5 concludes with the summary and conclusion.

1.8 *Definition of terms*

Edutainment is a media designed to educate through entertainment or games.

Entertainment is the action of provided or being provided with amusement or enjoyment.

E-Learning: A learning system based on formalized teaching but with the help of electronic resources.

2. Literature review

2.1 *Educational apps*

While the need of schools, students, educators, and parents for apps that take advantage of the latest mobile and touchscreen technology is high, the majority of educational apps that are available in popular stores such as Google Play and Apple's App Store, both free and fee-based, have no guarantee of educational value (Papadakis, 2020).

In the United States, a report from the New America Foundation and the Joan Ganz Cooney Center at Sesame Workshop characterizes the current state of the 'educational' app Sustainability market aimed at young children as a 'Digital Wild West', suggesting that parents should be wary of those claims (Vaiopoulou, 2020).

For parents and educators, choosing an appropriate educational application is a great challenge. The issue of what constitutes an educational app is therefore strikingly complex, since it implies the consideration of various scientific aspects. Thus, sometimes it is easier to identify what constitutes a lack of quality. For instance, Martens, Rinnert and Andersen reported that the presence of ads, including pop-ups and pop-unders, poor or inadequate design, and non-functional elements are disruptive to the educational process, while privacy violation issues, etc. further diminish the value of an app (Martens & Andersen, 2018).

Kucirkova, Messer, Sheehy and Panadero state that researchers who aim at proposing a conceptual framework for mobile learning applications face many of the same challenges as those researching educational software used for desktop computers. To highlight that, Hirsh-Pasek and her colleagues describe the current app market as the 'first wave of application development', in which already-existing non-digital material is being converted into a digital format. Indeed, most of them are found to be reproductions of their print-based counterparts of simple, enjoyable activities offering just passive learning experiences, even though apps with educational value should focus primarily on promoting education, and not just being entertaining (Kalogiannakis, 2020).

Shuler, Levine & Ree analyzed the best children's educational apps by evaluating the 100 educational apps available for the iPad and iPhone devices (200 apps in total). They found that more than 80% of top-selling paid apps in the Education category target children, 72% of which are designed for preschool-aged children. The study also revealed that developers' target audience was primarily parents seeking to cultivate a creative environment at home for their children. For anyone that is not a mobile educational technology expert, finding high-quality and

appropriate educational apps requires a great deal of time, effort, and luck because this procedure is not only hampered by both the sheer volume available in the stores and the inconvenient digital store user interface, but also by factors such as the lack of description, the misleading scoring system, the subjective user comments, ineffective and unworkable search algorithms (Stamovalsis, 2020).

Martens et al. noted that a simple search in the Apple App Store using the terms 'A, B, C' or 'Alphabet' returned approximately 279 to 286 results. Indeed, the world's two major smart device app stores do not provide the users with a user-friendly interface in which navigation is easy and reliable. Moreover, the information included on the principles followed and the methodology used by the development team is often not sufficient for successful decision-making. Although one might argue that information about apps is available in digital stores. This information cannot be used as a general criterion for evaluating the educational value. In fact, this content often comes from the app's creator, and therefore cannot be considered as accurate or reliable (Larkin, 2013).

In addition, there are very few tools for evaluating applications. Although there may be assessment tools in the form of rubrics and checklists developed by researchers at universities, parents and teachers either ignore their existence or find it difficult to use and interpret the results (Martens, 2018). Researchers such as Hirsh-Pasek et. al and Kucirkova also emphasize the fierce competition in the app market.

Kucirkova states that developing an application is a costly endeavor; the average cost ranges from 10,000 to 70,000 USD. At the same time, the average fee is about 3 USD, while most Android and Apple apps are available for free download (Kucirkova, 2016).

Given that the app market is highly competitive with dozens of new products introduced every week, commercial success is not just a result of their quality; it is also a matter of luck. In fact, success relates closely to the number of users who have chosen any given app from a plethora of similar products. Therefore, rapid growth in production and sale is a survival bet for most of the developers That may be a possible explanation about the phenomenon that lots of children's apps offer the same content with a slightly modified design, resulting into lack of effectiveness in academic terms while choosing among the most popular educational apps (Kaufman, 2015).

User reviews, star ratings, or the number of installations is often misleading for parents and teachers, who make a choice based solely on the aforementioned subjective and therefore unreliable criteria (Flewitt, 2014).

2.2 *Are there tools to help the general population to choose appropriate apps?*

The low quality of the majority of educational apps targeting preschool-aged children highlights the need for a tool to help parents and educators to evaluate the self-proclaimed educational apps for their real value. In 2019, using the validated PRISMA methodology (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Papadakis, 2020).

Various databases and digital repositories were searched for studies that met the following inclusion criteria:

1. Field study in smart mobile devices.
2. Describes an educational app assessment tool.
3. Reports on educational apps for children.

4. Scientifically sound.

The results collected during the review reinforced the importance of evaluation tools for educational apps. The study found 11 articles describing two different assessment approaches. Six studies present a rubric and five studies present a checklist. Additionally, the study also identified seven nonscientific-based tools. Four web sources present a rubric and three sources present a checklist. According to the researcher, the term 'nonscientific-based tools' refers to freely available online tools for the evaluation of educational apps that present their quality criteria without a focus on research methodology and scientific evidence (Papadakis, 2020).

In conclusion, the digital market is full of apps that are promoted as educational, but they have little or no pedagogical value because they are often made with limited input from educators or developmental specialists. Moreover, the majority of the tools presented in the relevant literature are not available for the parents, caregivers, and educators of young children, as they are stored in copyrighted digital repositories and databases. However, even if they were available, several questions arise in terms of their appropriateness, the time needed to complete an evaluation, etc. On the other hand, the freely available tools are considered as outdated and not appropriate in terms of their depth and scientific evidence.

This literature review pointed out the lack of reliable and easy-to-use evaluation tools and highlighted the need for a new, improved one to help everyone who is interested to choose apps with increased educational value. That tool must be easy to use, reliable, short enough, and able to be used as more than a general guideline.

2.3 *Serious games for education*

Being an integrated instrument for complementary education, serious games play an important role in the learning process and help students concentrate on the given subject. Perceived usefulness, ease of use and clear goals are benchmarks for satisfaction and effectiveness of serious games. When learners clearly understand the goals and easily use the game controls, they are willing to focus on the actual content (Raju, 2017).

Latest research in the field of serious games shows that there are specific factors, which influence the learning process – production, realism, artificial intelligence and adaptability, interaction, feedback and debriefing. Production describes the final product of serious games. Realism is the degree to which serious games meet users' expectations. Artificial intelligence and adaptability include any algorithms that improve user experience by meeting individual needs. Interaction in a serious game includes communication of the user with the game, other users or the teacher. Feedback and debriefing are means to evaluate and analyze the in-game experience and content. Designers of serious games should consider all these factors and integrate them in their games, to bring the best experience and maximum results to the learners (Kuo, 2017). Serious games can be used to effectively increase cognitive abilities and improve the result of education. They help learners reach their academic goals and encourage their participation in learning activities. Education that is based on games has been proved effective in social and cultural training, due to their cognitive and motivational effects (Wouters, 2013). To that moment, there is no unified classification of serious games, but the following major categories have been identified – Game-based learning, Gamification of learning, Organizational-dynamic games, Simulation games and Edutainment. Game-based learning uses video and electronic games for education.

The main purpose of these games is to combine the realization of learning goals and entertainment, offered to the player. Gamification of learning integrates game elements and techniques in the e-learning process. This is an educational approach for motivating students to gain knowledge in an interesting way. Its main goal is to increase the satisfaction and involvement

of the learners, by capturing their interest and inspiring them to keep studying the given resources. The actual game elements and techniques, used in the e-learning process are borrowed from existing board and/or computer games. One such element is the plot – in electronic games, players go through a predefined series of events, and in e-learning, students follow a plan set by the teacher (Gachkova, 2018).

3. Design methodology

This chapter explains the various research techniques and methodologies that I used to conduct this research project.

3.1 *Requirement elicitation*

3.1.1 *Interviews*

I interviewed teachers on the way an edutainment mobile game application can improve the current way of learning and areas that can be improved for proper user experience. I also examined the current way kindergarten kids are being taught and areas that need to be improved.

3.1.2 *Evaluation of papers related to the topic*

Papers have been gathered from various educational platforms: (i) Research Gate; (ii) Academia; and (iii) Google Scholar.

Papers and similar projects to the scope of study of this project. All the papers have been analyzed and reviewed. This study and implementation aim to further improve such systems.

3.1.3 *Stakeholder analysis*

The Researcher analyzes the interest that should be taken into account when developing or implementing the system.

Stakeholders

1. Teachers
2. Kindergarten kids
3. Parents

3.2 *System analysis and design*

Analysis of a system specifically involves reviewing a system, testing its functions, analyzing its effectiveness, specifying necessary changes and upgrades, and the quality of the output. Design of a System is the blue print of what the designer wants to implement.

3.2.1 *Analysis of the existing system*

The findings of this study reveal that the current way of teaching kindergarten kids needs improvement, with the introduction of games, it makes the learning experience more fun and exciting.

3.2.2 *Description of the proposed system*

The proposed system is a mobile application with that allows various users to access all the various services outlined in 1.6 of this report. It incorporates:

1. It allows quick tests for kids on Mathematics and English in the form games.
2. It has a feature for kids to draw in their mobile phone.
3. It has multiplication table for kids to easily understand the multiplication table.
4. Kids can view the alphabetical order in the form of picture to quickly understand and learn.
5. Kids can play games to improve their memory, to remember things easier.

Output specification

The proposed system has 1 output: Gives Result after the Task in the form of game.

3.2.3 *Feasibility study*

The feasibility research came to the following conclusions: Java (Android studio IDE) can be used to create an edutainment game application.

3.2.4 *Software development model*

The method of research used for this investigation is the Iterative Development Model of the SDLC method. A concurrent development cycle focusing on the iteration of each development process stage is the iterative model. It is often utilized for large projects. A rudimentary implementation of a short set of system requirements begins the iterative process, which uses development iterations to improve the system versions until the system fulfills its needs and can then be deployed. A new version of the software is produced at the end of each loop. A functioning model of the software was generated on the basis of the iterative model.

Iterative Development Model Process

The iterative process is an incremental process that consists of iterations that add more features after each iteration. The process of each iteration consists of:

1. *Planning & Requirements*: This step is to establish the requirements and prepare the required components for the upcoming iteration.
2. *Analysis*: Analysis is performed to pinpoint the appropriate business logic, process flow, and data models
3. *Design*: Any technical requirements (languages, services, tools, libraries) that will be utilized are also outlined in the design stage.
4. *Coding and Implementation*: The actual implementation and coding process involves the programmers writing programs to carry out the functions outlined in the requirements while following the analysis and design outlines.
5. *Testing*: On the completion of the programming phase, the output software would then go through a series of tests and trials to identify bugs or issues with libraries being used, and then correction procedures would follow.
6. *Evaluation*: Once all the previous phases are completed, the software would then go through an evaluation. This phase would allow all the stakeholders to examine whether the software meets its goal and what can or should be changed.

Then the most recent build of the software is created and the whole process is then brought back to the planning and development stage and the process repeats itself all over again until the software is completed.

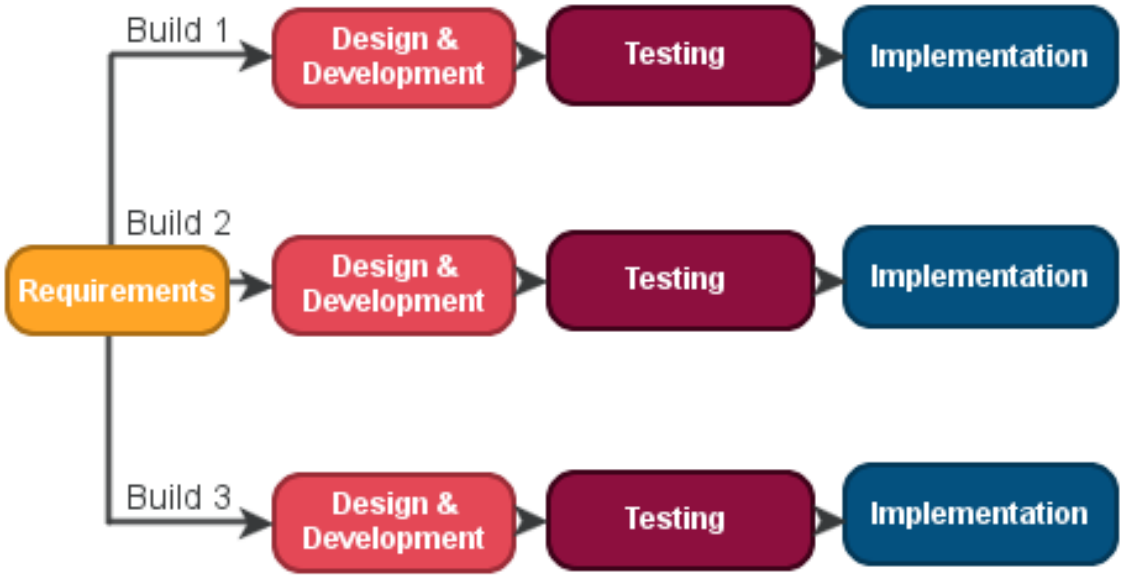

Figure 1. Iterative model of system development life cycle (t4tutorials.com)

It has the following phases: Requirements gathering and analysis, Detailed Design, Implementation, Testing, Deployment, Review, and Maintenance.

This SDLC method was chosen because:

1. It enables project development to begin with only a skeleton of a requirement definition.
2. It allows early detection of faults.
3. Encourages user feedback.
4. The amount of time spent on paperwork is reduced.
5. Software development takes up more time.
6. Some features and requirements may change in the future.
7. New technology is being used.

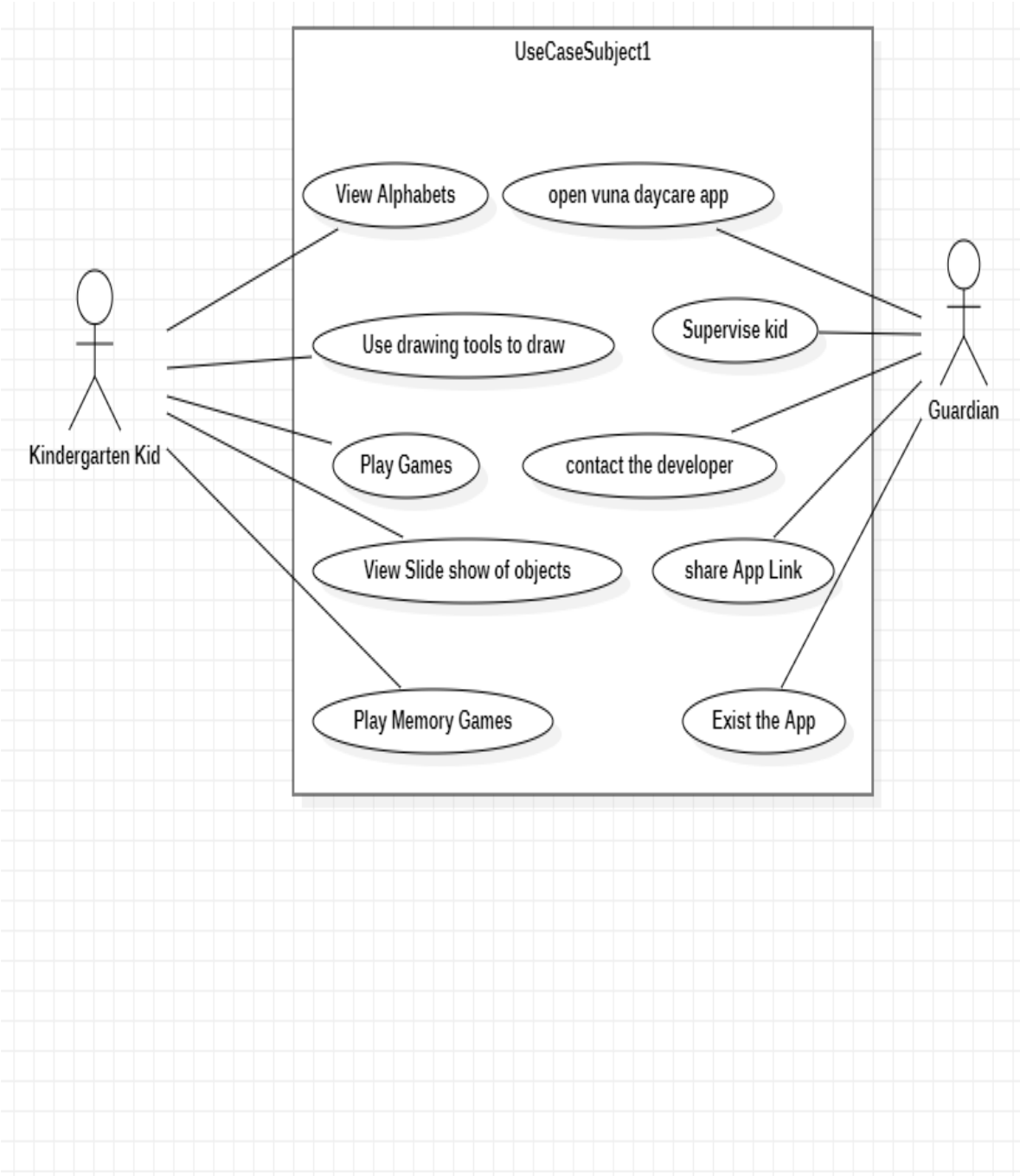

Figure 2. UseCase diagram of an edutainment game application

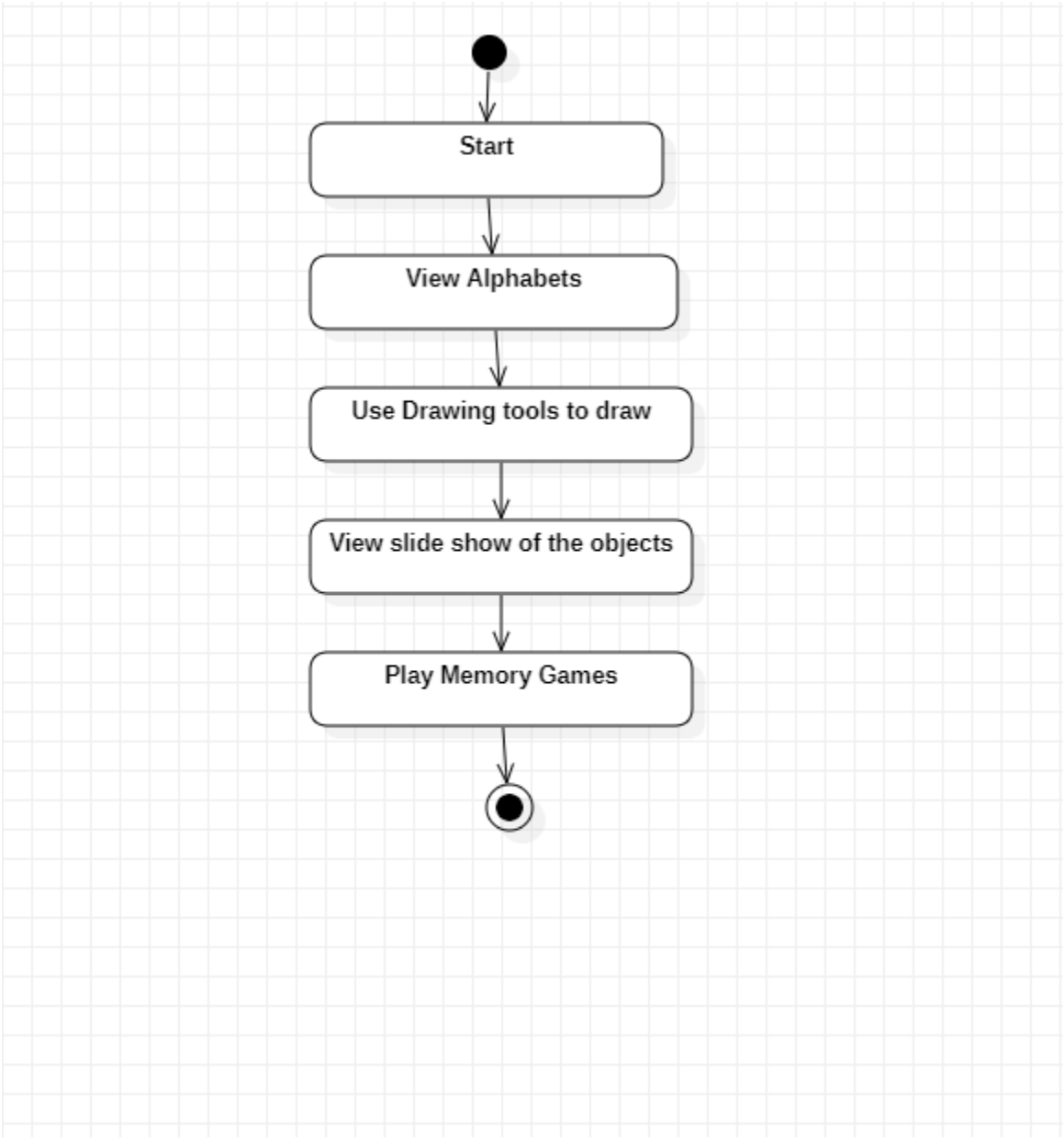

Figure 3. Activity diagram (Kindergarten kid) edutainment game application

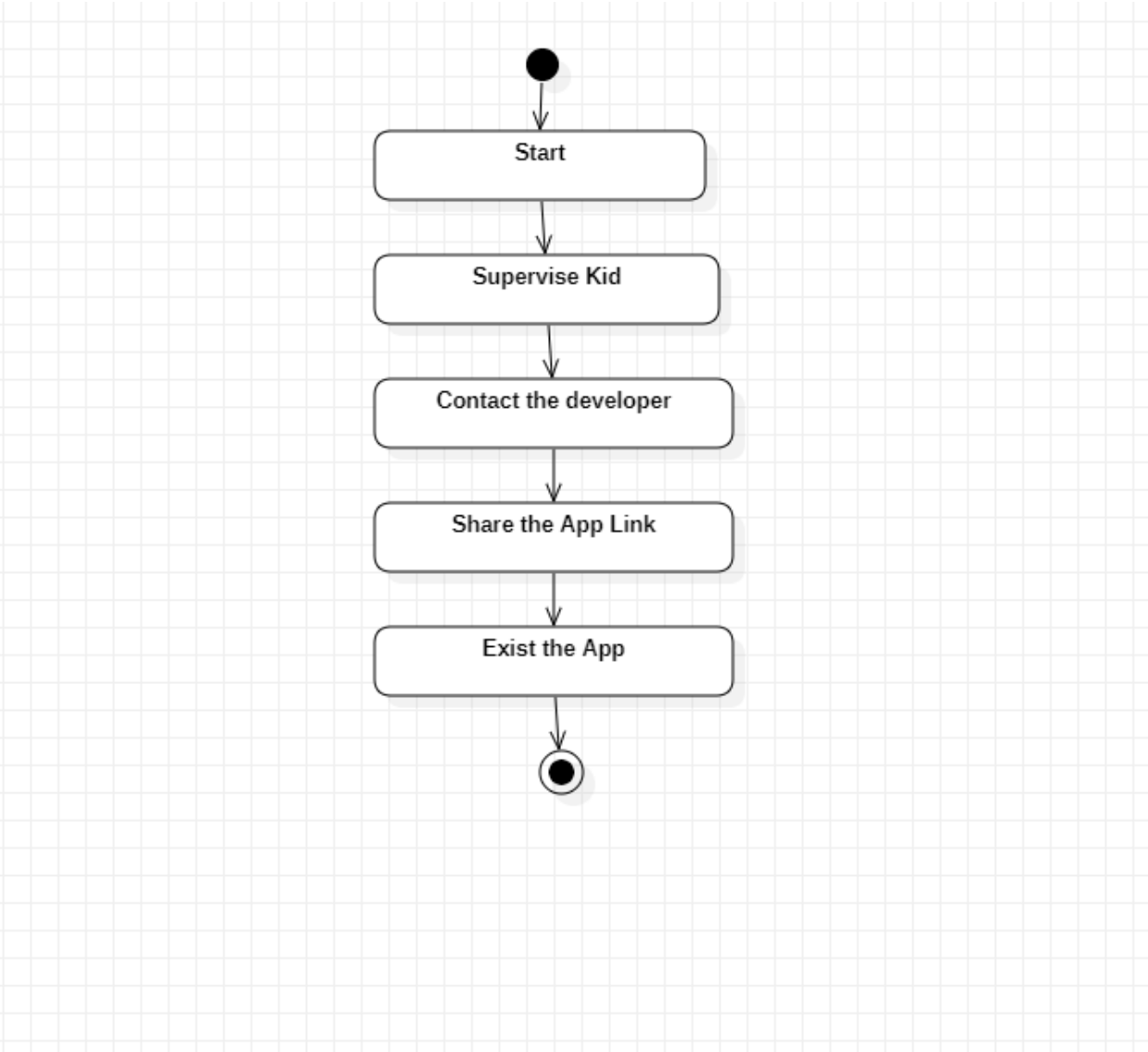

Figure 4. Activity diagram (Guardian) edutainment game application

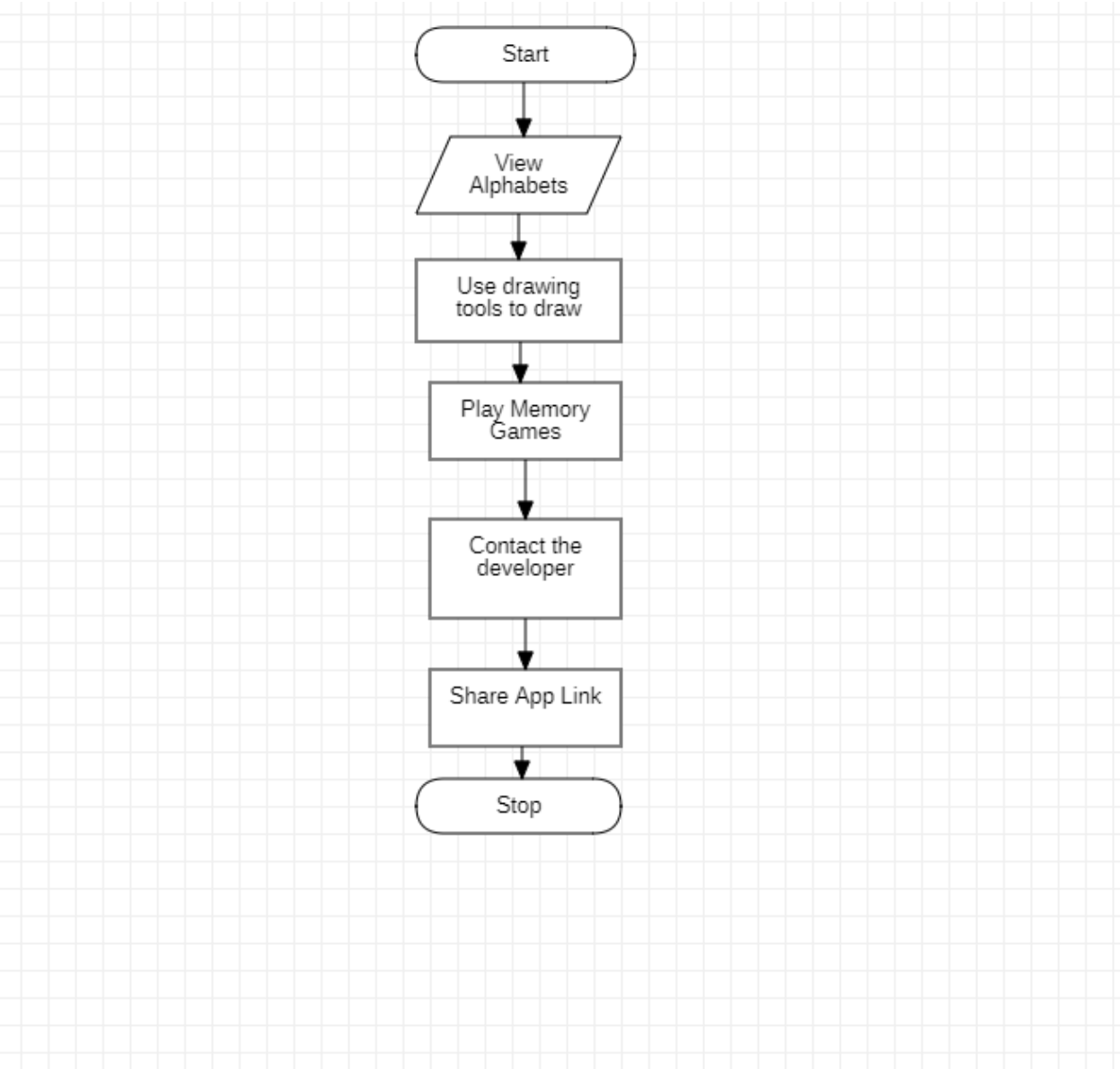

Figure 5. Flowchart of an edutainment game application system

3.2.5 *Development methodology*

The method of development of the application is object-oriented. OOP is a programming paradigm which portrays software design processes as objects for real life. These objects are entities with data fields (attributes describing the object) and processes known as methods connected with them. Objects in code format are usually class instances and interact to construct a computer application and programs.

Justification for the use of this development methodology

An Object-Oriented software enables:

1. Enhanced comprehension – The software development process is made easier by presenting object-oriented analysis.

2. Simplicity: it simplifies software design by presenting each module as an object and offers an efficient means of communication. The qualities, behaviors and relationships of the objects are described.

3. Code Reusability: The code for a certain feature is arranged in one file, it can be reused as much as possible.

Easy to maintain: One file does not have problems with the other files. The diagnosis can be identified and remedied easily to the source.

3.3 *System requirements*

Functional requirements

1. The system would be able to teach kids mathematics and English in the form of games.

2. The system would be able to make it for both teachers and parent in the learning process for kindergarten kids.

Non-functional requirements

1. The system would be easy to use.
2. The system would be safe to use.
3. The system would be fast and accurate.
4. The system would be user friendly and have good user interface and user experience.

Requirements:

- Laptop
- Internet Connection
- Mobile Phone

Software requirements

There would be no need for pre-installation of another software, the application just needs to be installed and then be able to run on a mobile device.

Hardware requirements

Mobile device.

People

1. Teachers
2. Kindergarten kids
3. Parent

3.4 *Proposed methods*

Hardware components

Mobile Phone: a mobile phone would be needed to run the application.

4. Implementation and documentation

System implementation means the conversion of the conceptual and logical designs of the system into operational life, resulting in a mobile application for this project. Deployment includes programing languages and libraries to be selected/installed, code written, debugged/test, documented/manual generated. This study included the installation of Android studio, Android studio is an IDE that is used to design and develop mobile application. The program works well on a mobile phone according to the design architectural structure.

4.1 *Development environment*

The development environment is the Android Studio. *Android Studio* is the official integrated development environment (IDE) google android operating system, built on JetBrains IntelliJ IDEA software and designed specifically for Android development. It is available for download on Windows, macOS and Linux based operating systems or as a subscription-based service in 2020. It is a replacement for the Eclipse Android Development Tools (E-ADT) as the primary IDE for native Android application development.

Android Studio was announced on 16 May 2013, at the Google conference. It was in early access preview stage starting from version 0.1 in May 2013, then entered beta stage starting from version 0.8 which was released in June 2014. The first stable build was released in December 2014, starting from version 1.0.

4.1.1 *Technology to be used*

1. Java: Java is a programming language that may be used to write programs. Java is used to write applications for different platforms that run JRE and supports applications that run on a single device like a desktop or mobile phone. Java can also be used to develop applications that work in a distributed manner.

2. XML: XML (Extensible Markup Language) is a markup language similar to HTML, but without predefined tags to use. Instead, you define your own tags designed specifically for your needs. This is a powerful way to store data in a format that can be stored, searched, and shared.

In this Project, the focal point would be on developing an edutainment game application for kids.

4.2 *Program structure*

The application is organized into components in its library it will include:

1. Front End: These are the static pages for the mobile application. (XML)

2. Android Studio IDE: This is the environment that deals with developing the mobile app.

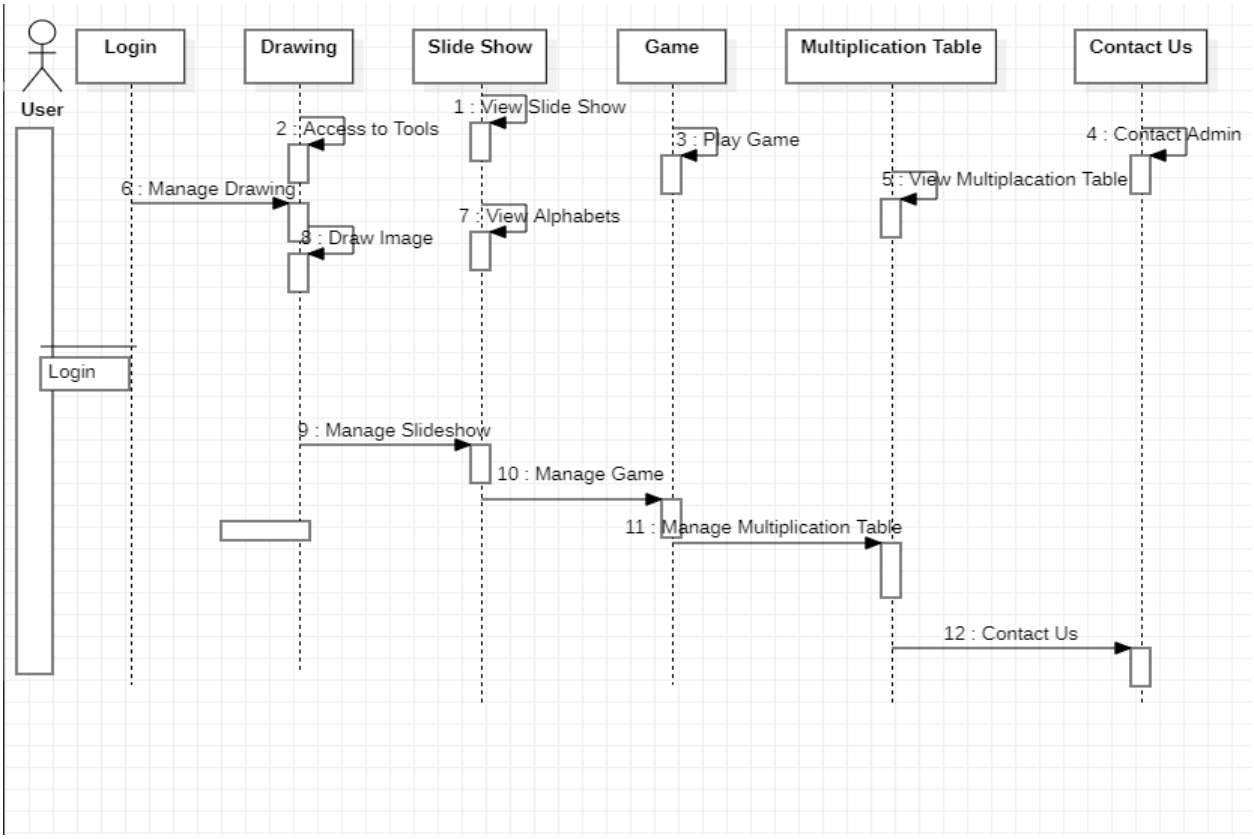

Figure 6. Sequence diagram of an edutainment game application system

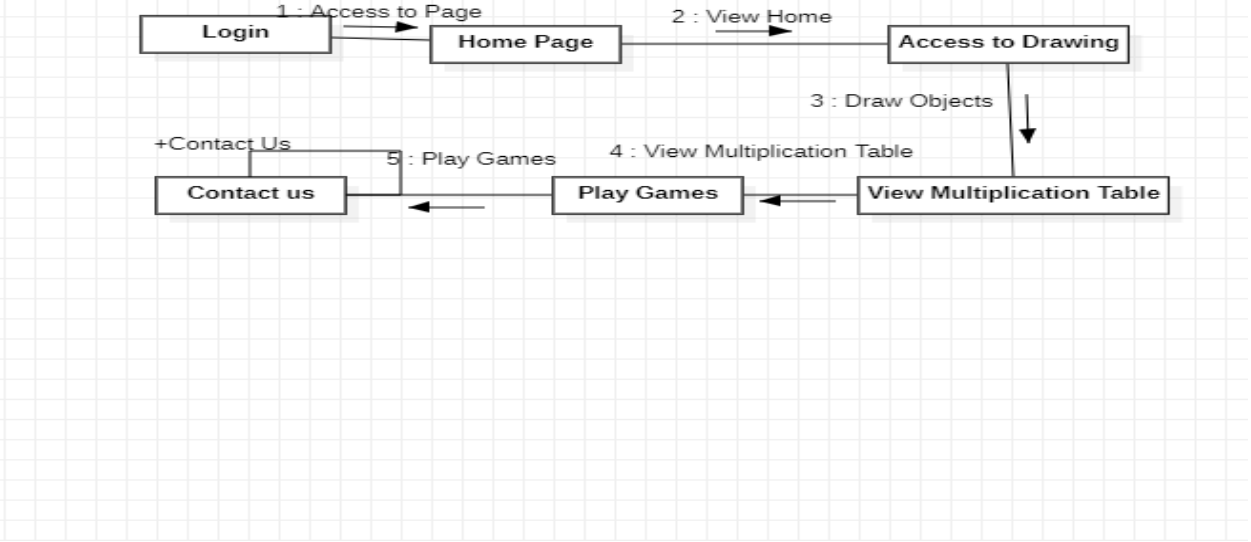

Figure 7. Communication diagram of an edutainment game application system

4.3 *Design tool*

The unified modeling language is the design tool employed in this work. This is a common graphic description for the study and design of software. UML uses symbols to define the application process and document it. If UML notation is employed, it gives an effective communications method and a complete system design explanation.

The system contains only 2 actors and the following can be modeled on administrators using a UML diagram.

4.6 *Documentation*

This documentation contains procedures to replicate the application and to install it. The Mobile Application is created in JAVA and XML using Android studio IDE; hence it must be installed for their environment.

4.6.1 *Software installation*

The process to install the software would be the same as installing applications on a mobile phone. All that is needed is for the application files to be transferred to the chosen system.

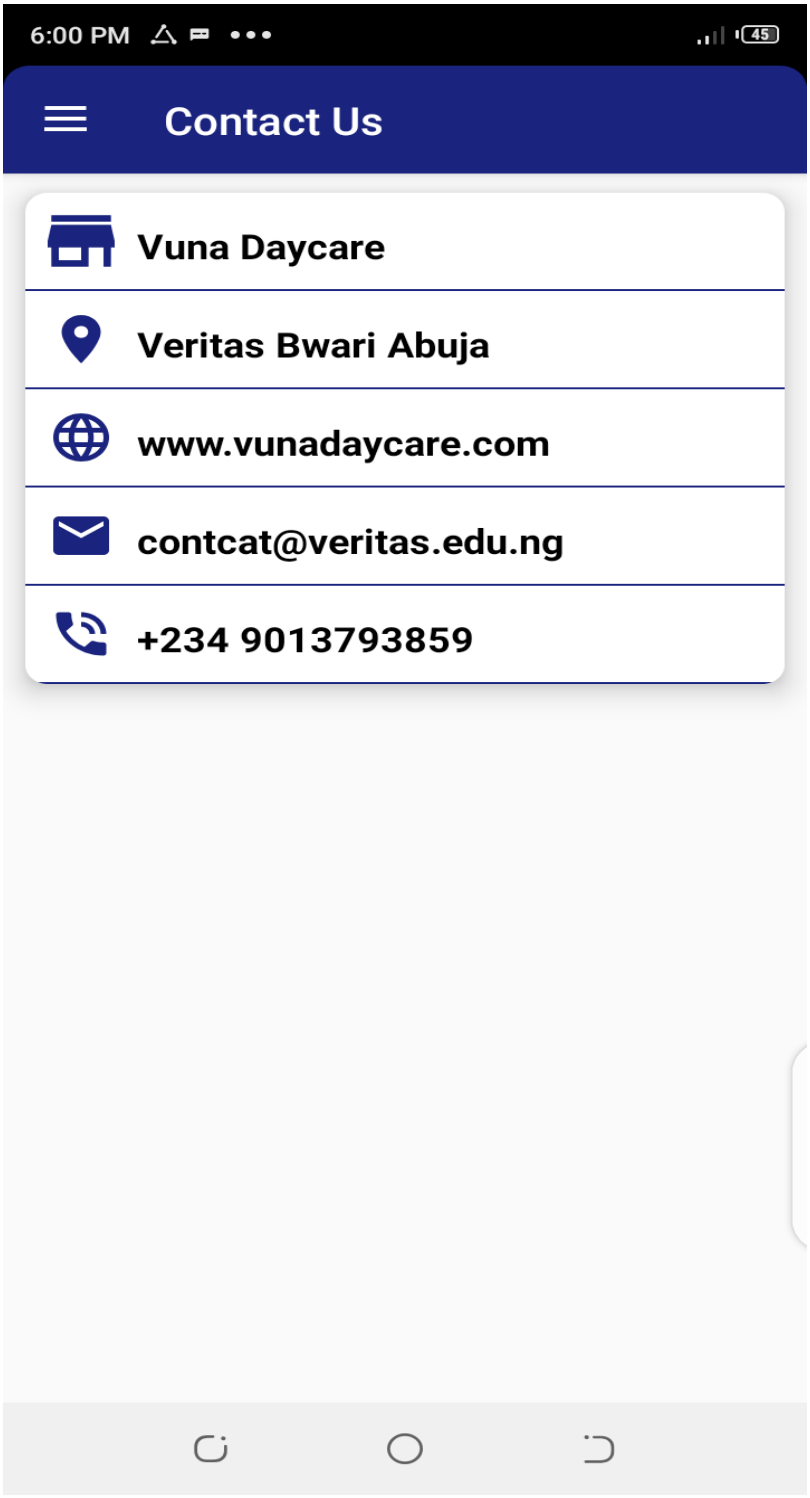

Figure 8. Contact page: Provides more information about the application

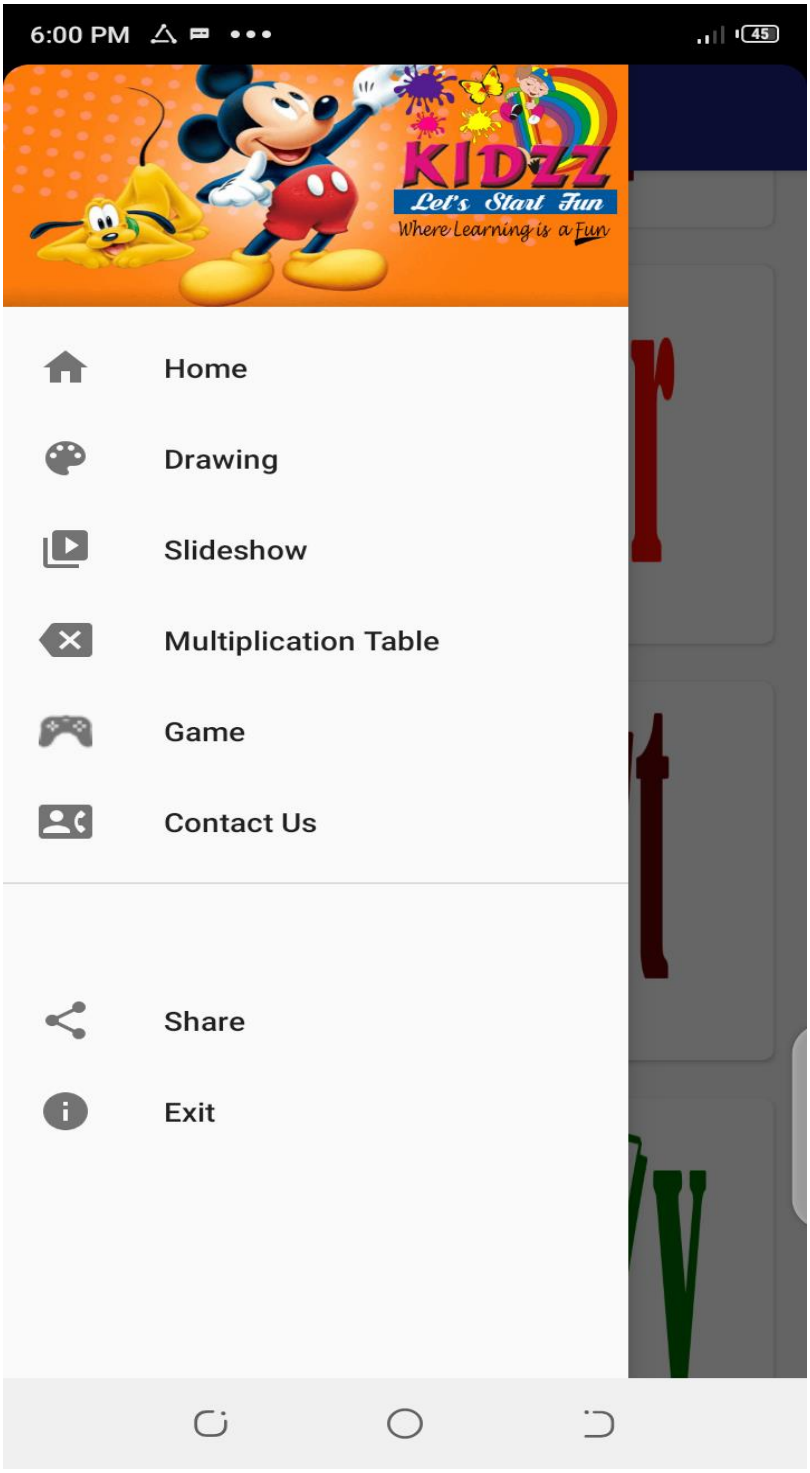

Figure 9. Menu page: It can link to the home, drawing, slideshow, multiplication table, game and contact us page

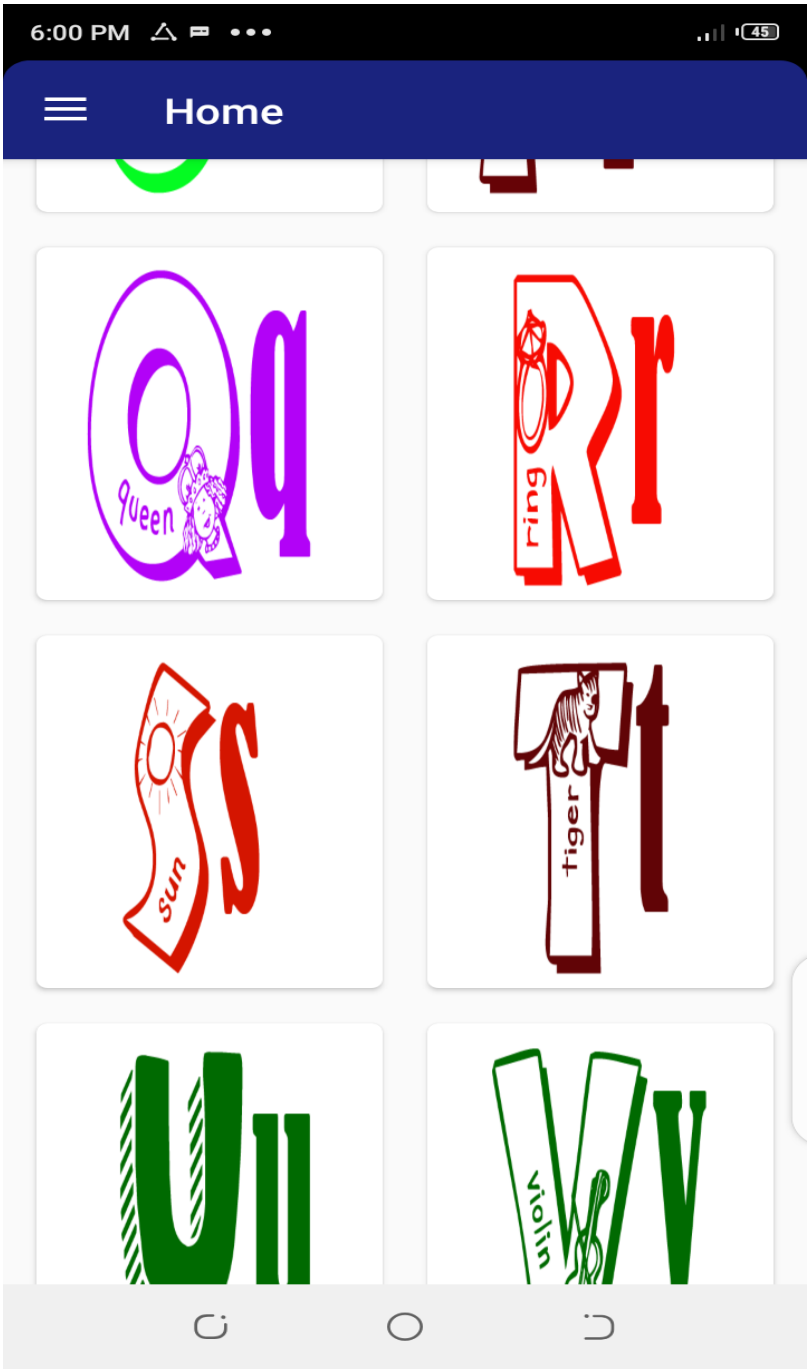

Figure 10. Home page: Where kids can view alphabets

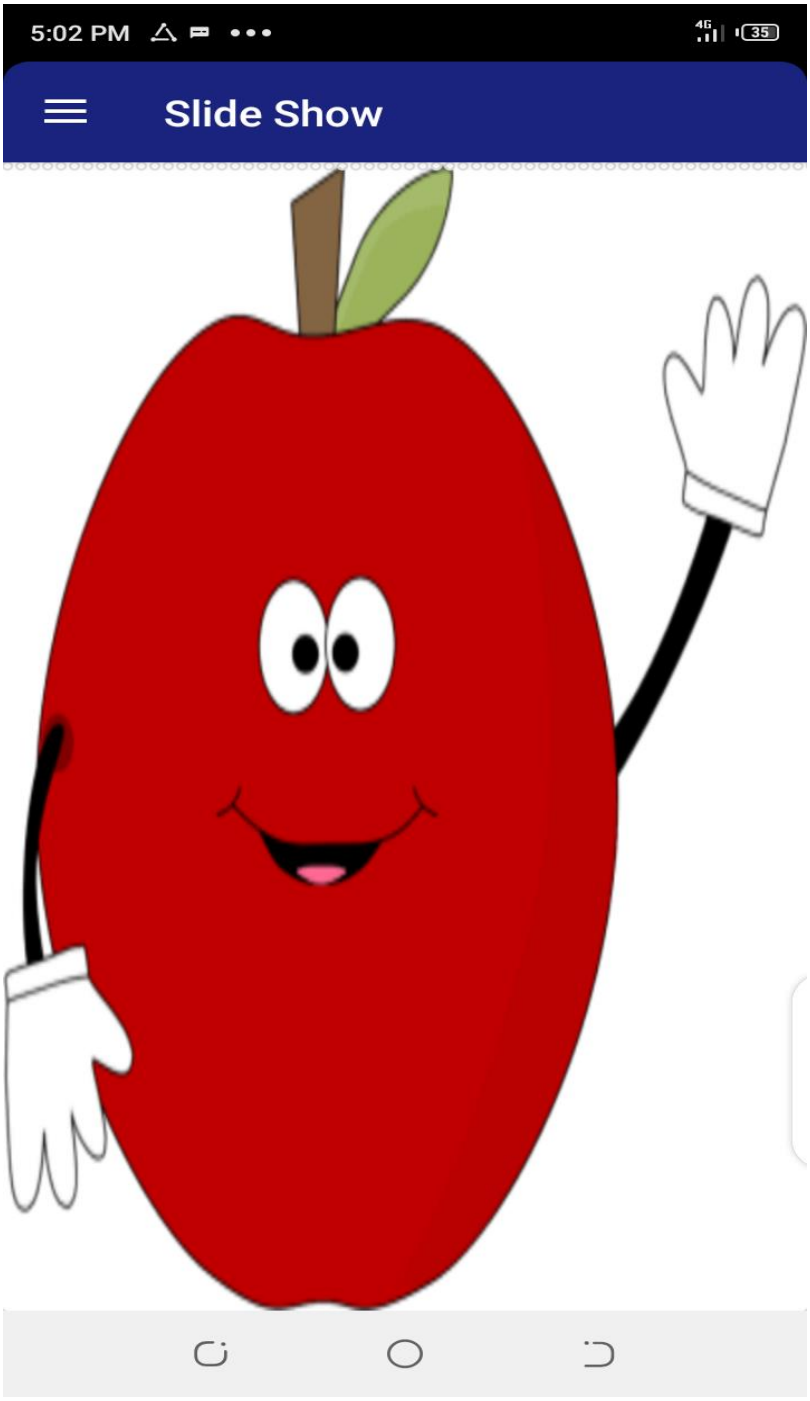

Figure 11. Slide show page: It shows the alphabets in English with imagery for quick remembrance

Figure 12. Drawing page: The page contains all the necessary tools for kids to draw

5. Summary and conclusion

This project would be a well-required solution for teaching kindergarten kids through the use of mobile phones and the kid need to properly supervise by the guardian for understanding of the proposed system. Kindergarten kid learning on a mobile phone is far better because the learning is self-paced and the kid would see the learning process in a more fun or interactive way.

The Edutainment Game Application developed is an automated solution to teach kids how to easily learn mathematics and English in a fun and interactive way compare to the kids been taught physical. It can be applied to many day-care institutions. The development of the system arose because of the high increase in the demand of E-learning, This System is to provide accurate teaching for the kindergarten kid, for easier understanding and to have good foundation on interacting with digital devices at a very young age. A lot of students have problem with Mathematics and English due to a very poor background at a very young age, this is a scenario of one of the problems an edutainment game application would solve.

Therefore, the new system targets to ensure an effective way of teaching kindergarten kids through an edutainment game application. Observing the high chance of learning physical without understanding. The new system is developed with the capability for kindergarten kids to understand, process and analyze information easily.

5.1 *Recommendations*

While developing this solution there were emerging issues that would require further automation. It is hoped that these issues would advance and promote further research in the Edutainment Game Application.

The system is expected to have high level of supervision by the guardian or teacher to reach the full potential of the mobile application.

Limitations of study

1. Support for other languages.

2. Limited to only Mathematics, English and Memory games.

5.2 *Conclusion*

E-Learning applications are considerably expanding the reach of current schools, both by providing students enrolled with a broader choice of educational materials and by providing learning opportunities to individuals. This paper shows the innovativeness of vuna daycare application that benefits the users.

For the kids, the system could bring a new way and experience of learning when playing the games application using mobile phone. for interaction with play-based concepts will help developers and researchers to make education games suitable for kids. While for the parents, having this product for their kids could help both of them to enjoy the concept of play to learn together at home. In fact, the system also has the potential as a teaching tool for the teachers to teach their students and create a new way of interactive learning at school. In addition, the system has its own special features emphasizing educational value through its applications, where it focuses on fostering learning in key areas such as creative problem solving, languages and mathematics.

5.3 *Area of further research*

As stated earlier in the limitations of the study, further research is needed for the effectiveness of an edutainment game application system. There is a need to research areas that can be used for future research.

There is still no scientific evaluation process in this work. Therefore, the next steps for this work are to evaluate the performance improvement of the games. For this, gamification

developed for the games must be improved for users, especially kids, to become more fun to play. Gamification of the application must be evaluated so it is suitable for the kids. Comparison between the acceptance of the usage of play-beyond the screen concept and without it can be evaluated in the future.

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The authors declare no competing interests.

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Drivers and Barriers to Adopting ICT: Mexican EFL Primary School Teachers' Perceptions

José Joaquín Enrique Erguera Guerreo

Autonomous University of the State of Quintana Roo, Cozumel, MEXICO
Department of Humanities and Languages (DHL)

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Abstract

Information and Communication Technologies (henceforth ICTs) have been widely used by English as a Foreign Language (EFL) teachers as a tool to enhance language learning. This study investigated the drivers and barriers of ICT adoption as perceived by EFL teachers at the primary school level in Mexico. A phenomenological approach was adopted, and semi-structured interviews were used to collect the data. The findings showed that teachers' positive attitudes towards technology, attention motivation, having access to ICT resources, and enhancing language learning are the main drivers which facilitate the use and adoption of ICT in their classrooms, while, lack of resources, emerging challenges when using ICT resources and teachers' demotivation are the main barriers. The study concluded that the current findings may help to better understand those factors, and hence inform EFL teachers, policymakers, and education authorities to develop actions to overcome the barriers and promote the pedagogical use of ICT.

Keywords: ICT, technology adoption, drivers, barriers, EFL teaching.

1. Background of the study

1.1 *Information and Communications Technology and EFL Teaching in the Mexican educational system*

English as Foreign Language was officially introduced into the curricula of all the levels of basic education including primary schools in 2009, by the National English Program (henceforth, PRONI), previously known as the National English Program in Basic Education (NEPBE) launched by the Secretariat of Public Education (henceforth, SEP). The main mission of this program as stated in their curricular foundations is to respond to the needs of,

> (…) contemporary society, predominantly governed by *information and communication technologies*, requires citizens with the competencies needed to insert themselves within a globalized changing world. Basic Education is responsible for providing students with the opportunity to develop these competencies (SEP, 2011: 87, italics by the author).

Correspondence: José Joaquín Enrique Erguera Guerreo, Autonomous University of the State of Quintana Roo, Department of Humanities and Languages (DHL), Cozumel, MEXICO.

- Teachers' beliefs that ICT resources facilitate the learning/ teaching process and enhance language learning were two of the main drivers.
- Attention-Motivation and having access to their own ICT equipment were relevant for the teachers to decide to use ICT tools in their teaching.
- The lack of ICT resources was the main barrier that hinders the use of ICT.
- Some teachers stopped using ICT because of the emerging challenges when using ICT equipment.
- Teachers' demotivation and lack of interest in the integration of ICT was also an important barrier.

These principles motivated the SEP to assume the responsibility to educate the future citizens with the necessary skills such as the use and command of ICTs and the knowledge of one foreign language in this case "English". Another, strong reason that pushed the creation of the PRONI was to reduce the gaps of inequality between students that go in private and public schools allowing with this that disadvantaged students have the opportunity to study English (Ramírez-Romero & Sayer, 2016).

The PRONI was designed into four cycles covering third grade of pre-school and all the primary and secondary school grades. These cycles were developed based on the Common European Framework of Reference for Languages (CEFR), additionally, the SEP developed a series of national standards for foreign languages called the National Certificate of English Level (CENNI, by its initials in Spanish). These standards were used to establish the expected levels that students should attain after having completed each PRONI cycle which was measured according to the hours of English teaching received, it is worth noting that on average students have 100 hours per school year of English instruction distributed in three classes of 50 min every week according to the school calendar. It is expected that when students concluded the four cycles, in other words, 3rd grade of secondary school, they will achieve a B1 level according to the CEFR levels. Figure 1 illustrates the expected achievement levels by cycle and grade based on the CEFR levels and the CENNI standards.

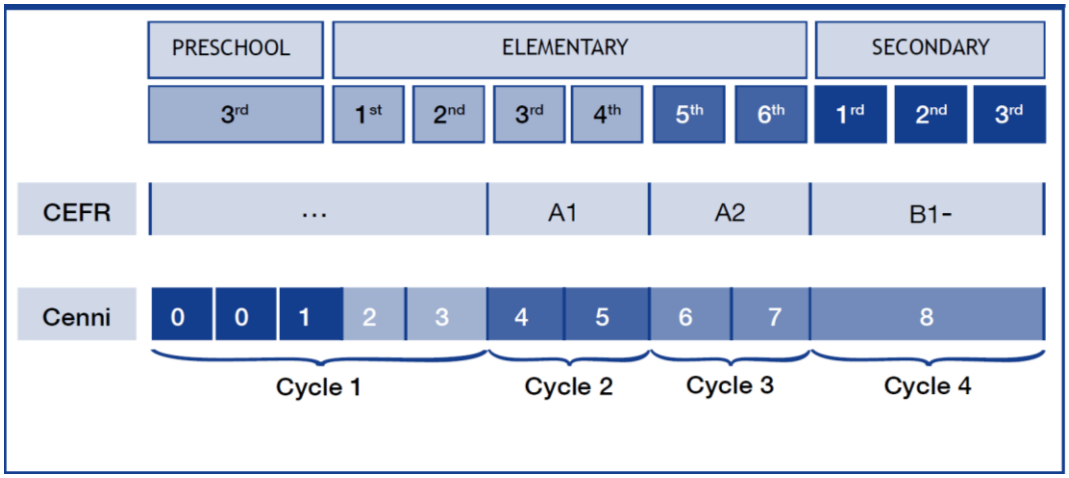

Figure 1. Expected achievement levels by cycle and grade
Source: Secretariat of Public Education [SEP] (2011: 66)

The educational policies and programs regarding the adoption of ICTs in primary public schools followed a similar path as the English language programs. According to Morales et al. (2002), the first ICT programs were launched in the 1990s which main goals were the installation of computer equipment in the classrooms, the establishment of computer labs or media classrooms, the creation of computer training workshops and the construction of training centres. However, it was until 2005 where the most ambitious ICT program was developed

"Enciclomedia" which was characterized for the digitization of textbooks, the distribution of multimedia resources, and the provision of computers, interactive whiteboards and digital projectors (Ramírez-Romero & Sayer, 2016). Enciclomedia was soon abandoned by the new Mexican authorities, however, in 2009 a new project called '*Digital Skills for everyone'* (HDT, by its initials in Spanish) was implemented in some primary schools where media and telematics classrooms were built and equipped with ICT equipment like computers with wireless internet access and educational software (SEP, 2009). The last two projects implemented regarding ICT were Mi Compu M.X and a pilot plan program called @prende 2.0. The former was launched in 2013 which the main objective was to provide of laptops with educational content to students from some primary public schools (Díaz-Barriga, 2014) and the latter started on 2014 and finished in 2018 which was implemented in some states and in a small number of schools where students of 5th grade were given some electronic tablets with educational resources (SEP, 2014). However, despite all these ICT programs, policies and strategies in the 2018 report of the National Institute for the Evaluation of Education in Mexico (INEE, by its initials in Spanish) informed that just 35% of primary public schools have access to at least one computer for educational purposes, however 52% of all these schools have no access to internet.

2. Statement of the problem

Despite the increasing academic research in the use, adoption and integration of ICTs in education, very little is known about the drivers and barriers of ICT adoption as perceived by EFL teachers at the primary school level in Mexico. A few studies have investigated the barriers and challenges that teachers face when using ICTs in primary public schools in the Mexican context (Santiago-Ramirez et al., 2013; Medina-Romo et al., 2017; Gomez-Dominguez et al., 2019). However, none of these studies provides evidence of the factors that facilitate the integration of ICTs as well as those internal or teacher-level factors that influence ICT adoption. This study is an attempt to fill this gap.

3. Research objectives

The main aim of this study is to identify the main drivers and barriers that facilitate or hinder the adoption of ICTs by EFL teachers working in primary public schools in Mexico. Gomez-Dominguez et al. (2019) carried out a quantitative study about the use of ICT by EFL teachers in the same context of this research, in which through the distribution of a questionnaire to 30 primary school EFL teachers provided evidence of the external or school level barriers that affect the adoption of ICTs, however, this study would have been more relevant if it had included evidence of the teachers' internal factors and explore the drivers of ICT adoption as well. This study attempts to complement Gomez-Dominguez et al. (2019) findings by analyzing teachers' perceptions of the drivers and barriers and provide evidence of both teachers' level and school-level factors.

4. Research questions

To advance the understanding of the main drivers and barriers of EFL teachers experience when using ICTs in primary public schools in Mexico. This study addressed the following two primary research questions:

> (1) What are the main drivers for EFL teachers using ICTs at primary school level in Mexico?

(2) What are the main barriers for EFL teachers using ICTs at primary school level in Mexico?

5. Literature review

5.1 *Theories about technology adoption and teachers' perceptions towards the adoption of ICTs*

According to the Unified Theory of Acceptance and Use of Technology (UTAUT) developed by Venkatesh et al. (2003), four factors explain what influences people's perceptions on the adoption of new technologies: performance and effort expectancy, social influence and facilitating conditions. A later review added three additional factors: hedonic motivation, price value and habit to provide insights into the technology user's perceptions as a consumer, and the model was renamed to UTAUT2 (Venkatesh et al., 2012) (Figure 2.1). Although the UTAUT2 model was not designed in the educational context, it provides insights into the factors and perceptions that may influence teachers' adoption of ICT in their teaching contexts.

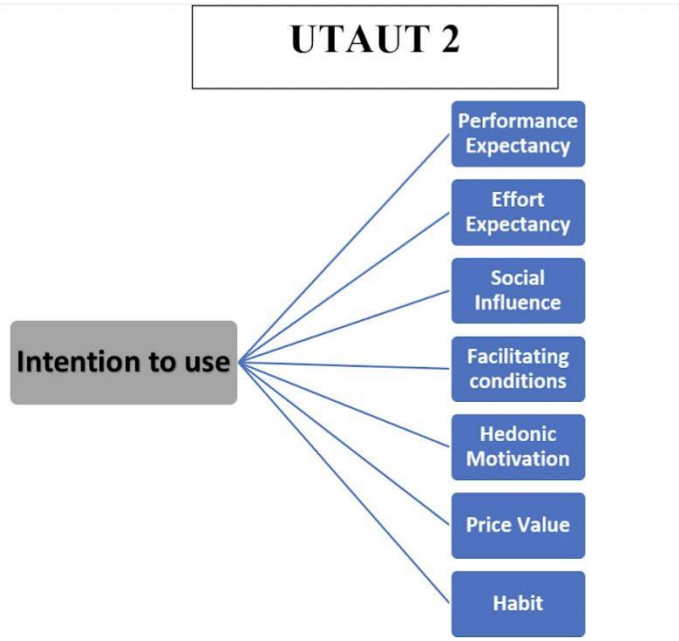

Figure 2. Unified Theory of Acceptance and Use of Technology 2

Based on the above model, teachers' perceptions can be broadly categorized into five major areas: performance expectancy, effort expectancy, social influence, facilitating conditions and hedonic motivation. *Performance expectancy* is expressed through the perceived benefits that teachers find when using ICTs to increase students' attention and motivation, saving time, developing effective activities (Jimoyiannis, 2008; Sipila, 2014). For example, the use of certain resources like audio-visual materials captures students' interest in the learning content. *Effort expectancy* is closely related to teachers' digital skills (Barbaran, 2014); most of the teachers are familiar with the new technologies, however, this issue should be evaluated in terms of teachers' pedagogical knowledge regarding ICT use. *Social influence* plays a vital role as students, parents and educational authorities expect that teachers' make use of these resources (Oyaid, 2009; Uluyul & Sahim, 2016); this means that teachers are pressured to include ICT resources into their teaching with the main goal to support learners' learning and equip them with digital skills, however, it is important to mention that teachers as well need to be encouraged and supported by their educational community including students' parents, colleagues and school authorities.

Facilitating conditions is perhaps the most influential factor because to teachers adopt ICTs successfully, they need to have access to ICT resources such as equipment, appropriate infrastructure, training as well as, technical and pedagogical support (Barbaran, 2014; King & Boyatt, 2014), if there is a lack of these facilitating conditions teachers will not be able to integrate these resources successfully. Finally, *hedonic motivation* as teachers need to be intrinsically motivated to use ICTs (Bennett et al., 2007; Jimoyiannis & Komis, 2007), the good thing in this perception is the fact that ICT use has the potential to motivate both the teacher and the learner, for example by using gamification or attractive audio-visual resources.

It is important to mention that by teachers' perceptions towards the use of ICT this study refers to the thoughts, interpretations and beliefs that are shaped because of teachers' background knowledge and previous personal and professional experiences which influence their practice in the classroom (Ertmer et al., 1999; Borg, 2006). To illustrate this point, Jimoyiannis (2008) developed a framework (see Figure 3.3) where all those internal and external factors that influence teachers' attitudes and perceptions towards the adoption of ICT are interconnected with each other. For instance, if teachers have ICT skills but lack of ICT pedagogical knowledge this last factor will negatively affect teachers' perceptions towards the use of ICT into their teaching practice.

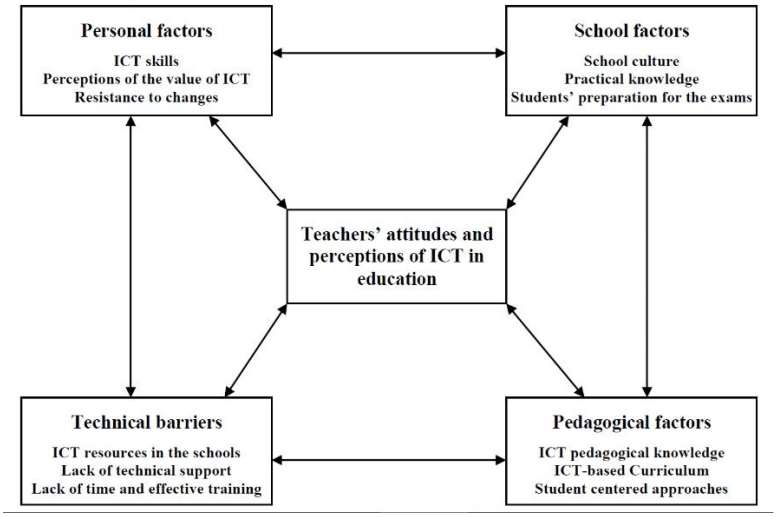

Figure 3. Factors influencing the adoption of ICT by the teachers
Source: Jimoyiannis (2008: 5)

Research carried out by Steel and Hudson (2001) reported that pedagogic, technical, social, and cultural perceptions and experiences of teaching staff towards educational technologies were vital to determine the factors that were facilitating and affecting the successful integration of ICTs in a UK university. Other studies have reported that although teachers' have positive attitudes and perceptions towards the adoption of ICT, their negative experiences such as technical barriers, and lack of support from their schools influence their lack of interest and demotivation towards the use of ICT in their courses (Al-Senaidi et al., 2009; Kopcha, 2012; Galvan-Malagon & Lopez-Perez, 2017).

There have been no detailed investigations about teachers' perceptions of ICT in Mexico. The studies found during the literature search were those focusing on teachers' beliefs towards the use of ICTs in primary and secondary public schools (Kalman, 2013; Andrade-Pulido, 2014). Both studies concluded that the contexts in which teachers work as well as their beliefs about teaching and learning determine their use of ICTs in the classroom.

6. Methodology

This study has adopted a qualitative mode of inquiry, in the form of a phenomenological research design. Qualitative research has been conceptualized as a "situated activity" in which the researcher adopts the role of the observer to provide "an interpretative, naturalistic approach to the world" (Denzin & Lincoln, 2011: 3). In other words, the researcher approaches the phenomenon into its natural setting, and interpret and make sense of it by analyzing and interpreting the data provided by the participants using his inductive and deductive reasoning to establish patterns or themes and, in this way, give meaning to the participants' voices (Creswell, 2013).

One of the main reasons that motivated me to choose a qualitative approach is because of the nature of this study which is targeted to identify the main drivers and barriers based on participants' perceptions towards the adoption of ICTs in their teaching practice and qualitative research design has the potential to identify and interpret those factors and provide an in-depth analysis (Creswell, 2013; Mills & Birks, 2014).

6.1 *Phenomenological research*

Phenomenology research is described by many academics as the study of the lived experiences of persons (van Manen, 2007; Denscombe, 2014; Cohen et al., 2018) which the main objective is to interpret and give meaning to those experiences and "not explanations or analyses" (Moustakas, 1994: 13). In line with this, van Manen (2017) claims that phenomenology as a qualitative research method aims to provide meaningful insights of the phenomenon under study, by providing "the richest and most descriptive data" (Creswell, 2019: 351). It is worth noting at this point, that phenomenology methodology as described by Denscombe (2014) is suitable for small-scale research projects because is economic and the main resource is the researcher himself. These two characteristics and the nature of the research questions were the main reasons that motivated me to adopt phenomenology research.

6.2 *Participants*

A final sample of seven EFL teachers met the sampling criteria described above and participated in the online semi-structured interviews. Table 1 below shows the participants' demographic information.

Table 1. Participants' demographic information.

Participant No.	Gender	Age	Teaching experience	Qualifications	Class
1	Male	41	7 years	BA (English Language) MA (ELT)	Years 1-5
2	Female	29	7 years	BA (English Language)	Years 4-6
3	Male	38	3 years	BA (English Language)	Years 1-6
4	Female	40	6 years	BA (ELT)	Years 1-6
5	Female	27	6 years	BA (English Language)	Years 1-3
6	Female	39	10 years	BA (ELT)	Years 1-6
7	Female	33	6 years	BA (English Language)	Years 1-3

6.3 Data *collection*

6.3.1 *Online semi-structured interviews*

Dornyei (2007) sustains that interviewing apart from being a communication routine, can be used as a "versatile research instrument" (p. 134). Denscombe (2014) makes the point that researchers opting for interviews should measure their feasibility as data collection method by considering the following three factors: Firstly, having access to potential interviewees who can describe what and how they experience the phenomenon under study (Moustakas, 1994). Secondly, considering the time and costs of travel, to tackle both issues I opted for video online interviews which allowed me to carry out the interviews in real-time while including visual contact without needing to travel to the study context. Thirdly, considering the kind of data that is needed, as the main goal of this research is to gain insights into teachers' perceptions regarding the use and adoption of ICTs, the best method to gather that kind of data is through in-depth semi-structured interviews (Moustakas, 1994; van Manen, 2017) because its flexibility mixed with well-developed and carefully selected questions allow the researcher to gain the desired information and have access to new lines of inquiry (Mills & Birks, 2014).

6.4 *Data analysis*

Moustakas's (1994) phenomenological approach of data analysis was chosen because its systematic procedures and detailed guidelines allow the researcher to provide rich and in-depth textual and structural descriptions and interpretations of the phenomenon under study as experienced by the participants (Creswell, 2013; Cohen et al., 2018). Figure 7. 1 illustrates all the steps involved in the Moustakas' method of data analysis.

From the verbatim transcript of your experience complete the following steps:

a. Consider each statement with respect to significance for description of the experience.
b. Record all relevant statements.
c. List each nonrepetitive, nonoverlapping statement. These are the invariant horizons or meaning units of the experience.
d. Relate and cluster the invariant meaning units into themes.
e. Synthesize the invariant meaning units and themes into *a description of the textures of the experience*. Include verbatim examples.
f. Reflect on your own textural description. Through imaginative variation, construct *a description of the structures of your experience*.
g. Construct *a textural-structural description* of the meanings and essences of your experience.

Figure 3. Method of organizing and analyzing phenomenological data
Source: Moustakas, 1994: 121

Moustakas' approach begins by identifying and bracketing out researcher's personal experiences with the phenomenon under study and in this way focus entirely on participants' experiences (Creswell, 2013), and finish with a composition of the textural and structural descriptions and interpretation of the data. It is worth noting that Nvivo 12 plus was used to store, organize and code the data effectively, and WordStat 8 was used to carry out word frequency analyses to identify the main themes, next section will provide accurate descriptions of all the data analysis procedures.

6.5 *Procedure*

After transcribing all the interviews verbatim and stored in a Nvivo 12 plus file project I proceeded with the data familiarization through reading and re-reading the transcripts many times to identify participants' significant statements regarding the drivers and barriers of ICT use in their teaching contexts. Then, I started classifying and grouping the significant statements into two nodes one for drivers and another for barriers, Nvivo 12 plus automatically stored all these statements into two documents one for each node. After that, I downloaded both documents to proceed with a word frequency analysis using WordStat 8 which revealed the most used terms in both categories, those identified keywords along with constant comparative analysis were used to cluster the main themes.

7. The study main findings

The phenomenological in-depth analyses of the collected data answered our two research questions. Table 2 summarized the study findings with its corresponding research questions.

Table 2. Study findings.

Research Questions	Answers	
1. What are the main drivers for EFL teachers using ICTs at primary school level in Mexico?	**Facilitates the learning/teaching process**	• Meaningful learning • Useful tool for teachers • Better than traditional teaching
	Attention-Motivation	• Increases student attention towards the learning materials • Increases student motivation
	Accessibility to their own ICT resources	• Having control over their own equipment • No relying on school ICT resources
	Enhance language learning	• Allow learners to have access to authentic materials • Facilitates the practice of the four language skills
2. What are the main barriers for EFL teachers using ICTs at primary school level in Mexico?	**Lack of resources**	• Lack of access to internet • Insufficient or inexistent ICT equipment • Lack of time • Lack of technical support and appropriate training • Lack of economic support
	Emerging challenges when using their own ICT equipment	• Inappropriate school and classroom setting. • Waste of class time • Classroom management problems
	Teachers' demotivation and lack of interest	• External or school level barriers • Teachers' status in the schools and inappropriate working conditions

7. Discussions of findings

The findings suggest four main drivers that encourage EFL teachers to use ICTS in their classrooms. The first one facilitates the learning/teaching process draws on the idea that ICTs are perceived by teachers as useful tools which allow them to create more meaningful learning opportunities and the shared belief that ICT use is more effective than traditional teaching practices and resources such as the use of textbooks. However, two participants in this study suggested that a mixture of traditional teaching practices and resources with the use of ICTs are effective as well, this perception is consistent with the observed by Izquierdo et al. (2017), as they reported that EFL teachers in Mexican secondary public schools use ICTs to complement the textbooks and provide learners with extra practice particularly listening. In the same way, Uluyol and Sahin (2016) found that primary school teachers in Turkey perceived ICTs as useful tools that facilitate their job and allow them to create more meaningful learning activities. In the same way, Sa´nchez-Mena and Marti´-Parren□o (2017) reported that university professors in Spain perceived ICT use as a more effective and easier in comparison to traditional teaching practices.

The second driver was attention-motivation as teachers reported that ICT increases learner's motivation and attract their attention towards the learning materials. This finding broadly supports the work of Kalman (2013) and Izquierdo et al., (2017) who reported that one of the main reasons that Mexican teachers in secondary public schools use ICT is to increase their students' motivation and attract their attention towards the class content.

The third driver was teachers having access to their ICT equipment this result may be explained by the fact that teachers do not need to rely on the limited or inexistent school ICT resources and have control on their equipment, Go´mez-Domi´nguez et al. (2019), Izquierdo et al. (2017) and Dominguez-Castillo et al. (2016) showed that is a common practice for Mexican EFL teachers in primary and secondary public schools to bring their own devices particularly laptops and speakers in order to overcome the lack of ICT resources in their schools.

The final driver was enhancing language learning as teachers reported that the main reasons to adopting ICTs are because it allows them to have access to a wide variety of ELT materials particularly authentic materials to provide learners with the practice of the four language skills, however, it was not of any surprise that teachers use ICTs primarily to provide learners with listening practice.

This study confirms that EFL teachers' use of ICT is mainly influenced by their internal factors such as their attitudes, beliefs, and perceptions (Ertmer, 1999; Jimoyiannis & Komis, 2007; Uluyol & Sahin, 2016). However, it is important to mention that facilitating conditions such as having their ICT equipment and performance expectancy such as enhancing students' language learning and increasing their motivation and attention play a vital role in their perceptions towards the adoption of ICT resources.

External barriers such as the lack of ICT resources and emerging challenges when using their ICT equipment because of the inadequate school infrastructure and facilities as well as internal factors such as teachers' demotivation and lack of interest were identified, however, it is important to mention that these internal factors are heavily influenced by external barriers like the lack of facilitating conditions and time as well as teachers' status in schools and their inappropriate working conditions that demotivated them to improve their teaching practice and growth professionally in their schools.

The foremost barrier reported by the participants was lack of resources which contemplates the lack of access to the internet, insufficient or inexistent ICT equipment, lack of time, lack of technical support and appropriate training, as well as lack of economic support to acquire new equipment. Teachers in this study consider that the available resources at schools are insufficient, scarce, outdated and of difficult access because of the many administrative limitations that hinder them to make use of them. These results coincide with those of Domi´nguez-Castillo et al. (2016), Izquierdo et al. (2017), and Go´mez-Domi´nguez et al. (2019), who reported that the

lack of resources, poor or inexistent internet connection, insufficient or obsolete computer equipment, and lack of technical and administrative support negatively affected the use of ICT by EFL teachers working in secondary and primary public schools in Mexico. Additionally, participants constantly reported that time constraints in and outside the classroom were perceived as a major barrier.

The second main barrier was the emerging challenges when teachers use their ICT equipment such as waste of class time, classroom management problems, and inappropriate school and classroom setting. Although many participants bring their equipment to the classrooms, the inadequate teaching conditions hinder them to take advantage of these resources. Similar results were found in this same context by Go´mez-Dominguez et al. (2019) as teachers in their study reported that in their schools, there is not enough lighting, the projector screen is inadequate, the scope of the sound equipment is not according to the size of the classroom, and the limited class time were identified as inhibitory factors for ICT adoption. In the same way, Izquierdo et al. (2017) found that the inadequate school facilities and equipment was perceived by Mexican EFL teachers in secondary public schools as a hindrance that makes them waste class time as they need to move to different classrooms and install their equipment in every classroom and deal with emerging technical problems which support is inexistent. Additionally, these factors generate that teachers' loss class control because learners' get easily distracted this is consistent with the reported by Ga´lvan-Malago´n and Lo´pez-Pe´rez (2017) who found that Secondary EFL teachers in Spain avoid using ICTs because makes them lose class control and authority when dealing with technical issues, particularly with large classes.

Finally, teachers' demotivation and lack of interest in the integration of ICT resources in their teaching are internal barriers heavily influenced by external barriers such as the lack of facilitating conditions, teachers' status in schools and discouraging working conditions these factors negatively affected teachers' interest to integrate ICTs and adopt new pedagogical approaches. These findings broadly support the work of other studies in this area linking EFL teachers' demotivation with their dissatisfaction with their working conditions, teaching materials and poor facilities (Aydin, 2012; Agustiani, 2016; Ueda, 2017). This finding is also consistent with the British Council (2015) and Mexicanos Primeros (2015) reports as they point out that EFL primary school teachers working conditions in Mexico have a negative effect on their motivation, as well as on their professional development and practice.

8. Conclusion and recommendations

This study suggests that the adoption of ICT is influenced by both internal and external factors. However, teachers' internal factors particularly their perceptions about the benefits, usability, and effectiveness of the use of ICTs in their practice are the most important as the adoption of ICTs in this context mainly relies on teachers and their ICT resources. However, it is important to mention that external factors such as having the appropriate facilitating conditions such as access to ICT resources, training, technical and pedagogical support from their school authorities as well as appropriate working conditions like work stability may act as an important fuel for the successful adoption of ICTs in schools. The study findings have important implications and recommendations for EFL teachers, policymakers, and educational authorities. Firstly, teachers' internal factors are key to the successful adoption of ICT is important for teachers to take the initiative to train themselves on the technical and pedagogical aspects of ICT use. Nowadays, there is a wide range of free Massive Open Online Courses (MOOCs) and many of these courses are targeted to EFL teachers about how to integrate ICTs in their teaching practice. Additionally, I recommend teachers to be involved actively into the educational community a develop strategies and projects in coordination with the school principals to acquire more equipment such as laptops and projectors as well as have a funding to overcome technical issues and give maintenance to the

school equipment, it is advisable to run fundraising campaigns and involve students' parents in this process.

This study as well raises implications for policymakers and educational authorities as they should develop strong ICT policies with a long-term plan and vision based on current educational research especially the ones carried out in the Mexican context. It is important that those ICT policies should put the pedagogic rationale first over the social and economic rationales as the main goal of education is not just train future workers if not build future citizens who are active participants into the knowledgeable and democratic society and the appropriate use of ICT can have the potential to achieve all these goals (Jimoyiannis & Komis, 2007; Oyaid, 2009). In the same way, educational authorities should provide schools with the necessary facilitating conditions such as ICT equipment, educational software that fits with the school curricula and improve the school facilities and infrastructure. To achieve these goals, it is necessary that educational authorities in coordination with school principals should develop strategies to monitor and evaluate the school infrastructure as well as the ICT equipment and its use with a pedagogical objective in mind. Furthermore, the incorporation of technical and pedagogical advisors and the development of personalized teachers' training based on the school realities, learners' needs, and available resources will facilitate the successful adoption of ICTs not just in the field of EFL if not in the whole educational system.

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Educational Data Analytics and Fog Computing in Education 4.0

Jackson Machii & Julius Murumba

The Technical University of Kenya, Nairobi, KENYA
School of Business and Management Studies

Elyjoy Micheni

Tom Mboya University, Homabay, KENYA

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Abstract

Universities are generating massive amounts of educational data. Most universities are now focusing on how to harness that data to optimize and visualize it to provide better and more extended education services. Given this scenario, a literature review was used to conduct this study guided by the following objectives: (1) Assess suitable fog computing and educational data analytics architectures; (2) Examine the opportunities offered by fog computing and educational data analytics; (3) Investigate fog computing and educational data analytics challenges; and (4) Examine disruptions and future directions of these technologies in Education 4.0. The study concludes that institutions must use integrated data analytics techniques and distributed technology systems to make decisions about administration, resource allocation, student retention, performance, and improvement strategies. The study also identified the challenges of using fog computing and educational data analytics and concludes that education 4.0 is a learning style that is aligned with the fourth industrial revolution, requiring transformational learning readiness.

Keywords: education data analytics, learning analytics, fog computing, Education 4.0.

1. Introduction

Different digitally connected learning systems have achieved international recognition in the wake of educational IT-enhancing innovations. Universities are creating vast amounts of educational data and are thus trying to harness that data to visualize and optimize it to provide better and more extended education services (Amor et al., 2020). The massive volumes of data, both structured and unstructured, are generated at the universities through a variety of processes from educational and administrative systems, contributing to educational big data (Hadwer et al., 2019). Advancements in Information Technologies and the COVID-19 pandemic are disrupting the education arena. That has led several educational institutions of higher learning to turn to Virtual Learning Environments (VLEs) as part of preparing, coping, and recovery strategies. Pecori (2018) noted that conventional forms of learning are growing towards blended learning, which makes use of virtual and mobile learning frameworks. Technologies such as fog computing and big data may create an innovative teaching platform system that can minimize network

Correspondence: Jackson Machii, The Technical University of Kenya, School of Business and Management Studies, Nairobi, KENYA.

broadband strain, reduce cloud server load, increase comprehensive computing ability, and reduce latency (Cai, Qin, Zheng, Li, Luo & Zhang, 2018). These developments, coupled with the IoT social revolution, have led to the integration of fog and cloud technologies in educational systems. Wearables and full-fledged devices (e.g., tablets and laptops) can provide valuable educational data (Pecori, 2018). It is possible to analyze and use large volumes of data generated by IoT devices to develop a variety of valuable services for end-users and customers.

Several universities are reaping the benefits of investing in information technologies that are enabling them to develop and facilitate educational strategies to attract more students. These include, but are not limited to, virtual and digitally-enabled learning systems and administrative systems. Jones (2019) observes universities' collected and analyzed students' digital behaviors using learning analytics technology. Educational data qualities, such as high velocity, volume, diversity, validity, and value, have improved learning analytics (Gupta et al., 2015; Matsebula & Mnkandla, 2017). A new computing paradigm is necessary to offer location awareness, comprehensive monitoring, and intelligent command and control because of the inherent geo-distribution of educational data. Fog computing, which extends computation to the network's edge, meets this requirement (Tang et al., 2017). The node in fog computing, as stated by Prakash et al. (2017) processes data. It must process a portion of the data before it sends it to the central server for the rest of the computations. As a result, fog is especially useful in large, scattered regions where connectivity may be uneven. As said by Raman (2019), an organization's fog computing facilities can accommodate numerous users, vehicles, wearables, sensors, and smart devices.

Many universities are facing challenges when it comes to harnessing educational big data, to optimize and visualize it to provide better and more extended education services. A new computing paradigm is necessary to offer location awareness, comprehensive monitoring, and intelligent command and control because of the inherent geo-distribution of educational data; and Fog computing, which extends computation to the network's edge, meets this requirement (Tang et al., 2017). The scenario that universities are generating massive amounts of educational data motivated the study. Because data volumes are increasing, few institutions have been able to capitalize on the benefits of information they collect daily through their core business of learning and teaching. Education 4.0 initiatives, strategic formulation, support of e-learning, and innovation are viewed as significant steps to transformation and change during a crisis, supporting the preventative measures and recovery of higher education while trying to mitigate the impact on students and learning continuity.

2. Educational data analytics

Big data streams are rapidly becoming a major paradigm in data science. They appear in an ever-expanding variety of fields – novel platforms that comprise different applications, users, and devices typically generated on the web, sensing, smart systems, and so on. To deal with virtually infinite streams, non-stationary data, and constantly changing aspects of knowledge, precise methodologies and technologies are mandated (Pecori, 2018). Big data analytics refers to the process of gathering, assembling, and analyzing large amounts of data to extract useful information and patterns (Klašnja-Milićević et al., 2017). Hadwer et al. (2019), likewise big data are driving most organizations in the direction of enabling growth and sustainability. The companies like Google, IBM, Netflix, and Amazon use Big Data analytics to forecast customer behavior and usage patterns to improve products and services. Cloud services can be used to gain access to usage analytics, such as watching, purchasing patterns, and preferences, to improve target marketing. Endeavors to envision the prospect of education frequently emphasize novel technologies, such as ubiquitous computing devices, flexible classroom designs, and innovative visual displays, as well as data and analytics (Siemens, & Long, 2011). Klašnja-Milićević

et al. (2017) agreed that apart from educational performances that most universities have affirmed the critical importance of analytics in resource equity distribution, administrative activities, finance, and student achievement. Alkhalil et al. (2021) ascribed that big data analytics allow universities to precisely measure and forecast key performance indicators, resulting in rational and strategic decisions. Academic achievement, educational quality, research, courses or curricula, processes accountability, growing student diversity, and student retention are the most important issues in higher education institutions around the world (Matsebula & Mnkandla, 2017). MacNeill et al. (2014) cited some of the driving forces behind educational and learning analytics applications. These encompass: (i) offering information to assist institutional administrators in making decisions about marketing and recruiting and selection, as well as effectiveness and efficiency indicators, (ii) individual students can use analytics to focus on their achievements and behavioral patterns in contrast to their colleagues, (iii) assisting teachers and support staff in developing supportive interventions for groups and individuals, (iv) identifying students who could require additional assistance and attention, and (v) providing functional groups, like as course teams, with the ability to enhance existing courses or design new curriculum offerings.

The findings of Huda et al. (2016) show that BDA is critical in improving decision-making, providing insights, discovering facts, and optimizing the education processes. Therefore, it is significant for higher education institutions to use BDA-based Education 4.0 which includes innovative teaching and learning strategies to maintain sustainability in providing students with innovative learning experiences. The primary role of learning analytics is to generate valuable information that can be used in data-driven decision-making. This information may provide insight into a student's involvement with a university (Alblawi & Alhamed, 2017). MacNeill et al. (2014) pointed out that educational data analytics and fog computing is beneficial to administrative, training, and educational materials, including how learning resources are used, by who, and under what scenario. It also provides more contextual information for strategic planning and creativity in course design and delivery. A study by Banihashem et al. (2018) indicated that educational data analytics and fog computing could provide positive effects on education, like increased student engagement, improved learning outcomes, identifying at-risk students, actually providing feedback in real-time, and customization of education for Education 4.0.

3. Fog computing

For a complicated geo-distributed network of IoT devices, Cisco has developed a new computing paradigm called fog computing. As Abdulqadir et al. (2021) pointed out, cloud computing is incapable of managing local issues involving multiple IoT parts, as well as applications requiring the swift attention of a local controller (which cloud computing lacks). Fog computing is therefore necessary. IoT components are reasonably near to cloud computing, and it keeps data in both the cloud and fog nodes. Nowadays, the Fog Computing paradigm has developed as the ideal partner for big data streams, which aim to decrease the quantity of data that has to be transferred to the cloud for processing, analysis, and storage. Goals are to increase network efficiency by moving computing resources, applications, and services to the network's edges (Pecori, 2018). Zhang et al. (2018) define fog computing as a virtualized architecture that enables services such as storage, computation, and networking across collaborating end devices and data centers. The Fog Computing paradigm, also known as Edge Computing, extends the Cloud Computing paradigm to minimize latency, increase location awareness, reinforce mobility, and drive business (Mahmood & Ramachandran, 2018). Fog Computing is capable of delivering data analytics capabilities closer to the actual equipment that generates the data, such as at the network's edge, avoiding the broader Internet (Abdulqadir et al., 2021). Prakash et al. (2017) observed that when many non - homogeneous wireless devices join and interact with each other and with the network, fog computing may perform storage and computation activities without the

interference of third parties. Fog Computing distributes computing capabilities and application services in rational, efficient locations anywhere between the data source and the cloud. Fog computation is a distributed computing platform that extends the grid's typical computing cloud applications (Abdulqadir et al., 2021).

4. Methodology

The study was conducted based on desktop research guided by Google Scholar using keywords such as Education Data Analytics, Learning Analytics, Fog Computing, and Education 4.0.

5. Fog computing and educational data analytics architectures

As a concept, fog computing refers to the work of a highly dispersed, virtual environment that provides processing, network, and storage services between sensors and cloud data centers. To reduce latency and network congestion, cloud-based computing has been pushed outside, resulting in "fog computing" (Adel, 2020). Further than replacing cloud computing, the goal was to grow and augment it. Cai et al. (2018) regard fog computing as an extension of cloud computing, which is the "fog server" connected to many Internet of Things (IoT) infrastructure devices. Because of highly dispersed fog nodes, fog computing is useful for Internet of Everything applications that require consistent latency in real-time (Prakash et al., 2017). Virtual computing, also known as edge computing, is a more distributed computing service model based on cloud computing that has the following characteristics: proximity to the user, low latency, high confidentiality, high reliability, a dense geographic space for the distributed network, multiple nodes, wireless access network equipment, etc. In addition to its processing efficiency, it provides network security monitoring, real-time analytics, and capabilities for close-range source management, as well as real-time interaction and cloud online analytics support (Cai, Qin, Zheng, Li, Luo & Zhang, 2018). A notable feature of fog computing is that it extends cloud services to the network's edge. It accomplishes this by collecting local resources and bringing communication, control, storage, and computing functions closer to the clients (Neware & Shrawanka, 2020).

The fog system comprises fog nodes, which are a range of devices at the edge of the network with embedded management systems. It also contains simulated data center edges. Fog computing, in relation to the study by Neware and Shrawanka (2020), acts as a connecting connection between cloud and edge users. Through the use of wireless connection platforms like Wi-Fi, Bluetooth, and 4G, fog nodes are used to link end appliances and devices with users to provide services such as data management and processing. So, the fog computing system enables the assessment of data and the decision-making process at a quick rate. Fog computing is a decentralized computer infrastructure comprising three stratified tiers which help in the computation, storage, and processing of data. It is like edge computing because it contributes to specific advantages in IT. Adel (2020) and Neware and Shrawanka (2020) describe it as a three-tiered decentralized computer architecture that aids in computation, storage, and data processing. These are:

> Terminal tier: This layer is the closest to the end-user and the actual world in terms of physical closeness. Cell phones, sensors, smart cards, smart cars, etc are all included in this category. They are usually widely scattered and sense and gather information about actual events or objects, then send it to the tiers above, either for saving or processing, before returning it to the lower tiers.
>
> Fog tier: There are many fog nodes in this layer, which are at the edge of the network. We may find nodes of fog in a variety of settings, including retail malls and bus terminals as well as parks and city streets. Because of the sensing, they can convey,

quantify, and preserve data. By connecting to the cloud's data center via the IP core network, fog nodes can work collaboratively with the cloud to improve their capabilities for storing and processing data.

Cloud tier: Storage, storing, and processing capabilities are quite high on this tier, which is why it can do a broad range of computation analysis as well as store and save enormous amounts of data and information. According to IoT architecture (Adel, 2020), the cloud layer or data center layer is the uppermost layer in the system's design. This layer is responsible for enabling network access to all shared resources in the IoT network conveniently and appropriately. Figure 1 illustrates the fog architecture.

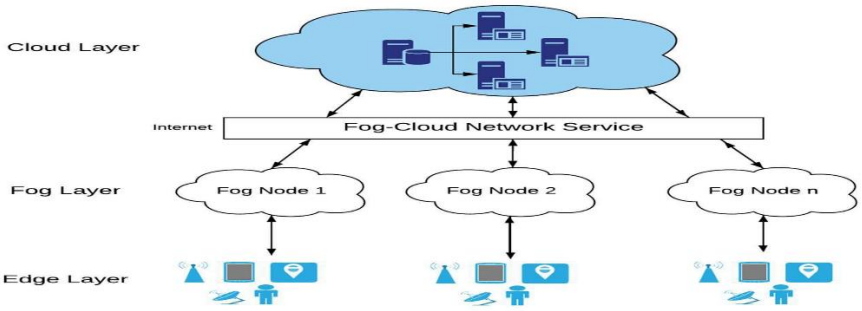

Figure 1. Fog computing architecture, adapted from Neware & Shrawanka (2020)

6. Education 4.0

Education 4.0 is the educational equivalent of Industry 4.0. It is referred to as educational reform, and it aims to satisfy the expectations of Industry 4.0, particularly the workforce requirements for it (Himmetoglu et al., 2020). Hence, Education 4.0 is a preferred learning style that aligns with the upcoming fourth industrial revolution. Higher education sectors make significant contributions to a country's overall economic and social development (Alkhalil et al., 2021). Given the fact that data volumes are increasing, few institutions have been able to capitalize on the benefits of information they collect daily through their core business of learning and teaching until recently (MacNeill et al., 2014). The advancement of novel technologies encompassing digital learner records, devices, flexible classroom plans, and Massive Open Online Courses (MOOC) is fundamentally altering the approach to learning culture and teaching(Jones, 2019). Student information systems, social networks, learning management systems, blogs, research, and so on all contribute to big data in higher education (Matsebula & Mnkandla, 2017). Higher education entailed many interconnected dimensions, such as psychological, social, scientific, cultural, human, and intellectual, all of which contributed to the achievement of its objectives and goals (Alkhalil et al., 2021). Bonfield et al. (2020) stated that currently there is no primer as to how to plan, teach, or deliver Education 4.0. Besides, it is important to note that not all institutions are the same and will therefore move at varying rates based on their economic, social, or political setting – it is indeed difficult to plan for outward disruptors like global pandemics (COVID-19), changes in regulations from the government, and technological innovations.

Tulasi (2013) postulates that the adoption of technology is greatly establishing most institutions' competencies, particularly in dealing with emerging challenges. The impact is quite motivating when appropriate technology is aligned with educational mandates such as objectives and standards. The underlying forces, both internal and external, necessitate higher education, which has no choice but to adapt quickly to the changes. By arbitrarily pushing computation nearer to where education data is created and utilizing a geographically distributed myriad of

heterogeneous systems in data centers extending the wide spectrum from the Cloud to the IoT, fog computing help effectively promote time-sensitive and bandwidth IoT applications (Brogi et al., 2018). Typically, in the education field, fog computing technology enhances educational operational activities and gives an agile platform, rather than slowing or discontinuing them (Raman, 2019). The core elements defining Education 4.0, according to the findings of a study conducted by Himmetoglu et al. (2020) are free access, personalized education, mental change, digital technology integration into education, streamlined learning environments, continuous learning, explorative education, and interdisciplinary education. Their findings also revealed that the main characteristics expected of students in Education 4.0 are participation, communication skills, technical knowledge, learning skills, and personality traits. Likewise, instructors of Education 4.0 are expected to have technical knowledge, leadership abilities, intellectual growth, and personal characteristics. Finally, the key qualifications anticipated of Education 4.0 institution managers are guidance competencies, technological skills, cognitive abilities, and analytical ability.

Kruse and Pongsajapan (2012) noted that institutions are currently ecstatic about the promises and opportunities of analytics in higher education. Analytics in academic contexts aims to allow institutions to leverage the data generated through learning management systems (LMSs) and other online databases and then use it to better the lives of the university and, apparently, the learners. Decisions on the progress of academic students, future performance predictions, and the recognition of potential issues can be realized via fog analytics (Lee et al., 2020). Badidi et al. (2020) in their studies posit that educational data processing and analytics must depend solely on interoperable messaging systems, sophisticated software engines for data stream processing, and optimized data storage strategies. Fog computing plays a crucial role in this by effectively addressing big data storage issues. It facilitates fast computing and analysis of data to adapt effectively to many happenings in institutions that demand urgent decisions and actions. Learning analytics, according to Banihashem et al. (2018) provide unique insights into education; there are ethical, educational, and technical concerns with the use of learning analytics in education. Sin and Muthu (2015) claimed that researchers are interested in educational data analytics with datasets to focus on improving education, particularly via the coordination and teamwork seen between educational data mining and learning insights communities. In addition, researchers are working on developing mechanisms and dashboards for data visualization to assist students and teachers in visualizing learning trajectories.

7. Leveraging opportunities and applications in education

Ciolacu et al., (2017) showed that many tasks and activities that humans have traditionally performed will be displaced because of the impact of digital transformation on industries. The great potential of Industry 4.0 is found in data and the effective use of newly acquired opportunities and challenges. Students' active and interactive presence contributes to higher learning quality in the fourth revolution in Education. It is crucial to acknowledge that simply having data access will not have a major effect on higher education institutions; people must contextualize, respond to, as well as understand the data (MacNeill et al., 2014). Viberg and Grönlund (2021) indicated that gathering, evaluating, and presentation of data about learners and their contextual factors for the aim of comprehending and improving learning and surroundings is referred to as educational data analytics. Educational fog data analytics can have a large-scale influence on student learning by providing important insights into the mechanisms of online and face-to-face learning, along with promoting active learning through data analytics. The overall aim of intelligent education under intelligent architecture is to deliver customized services and a seamless learning experience for every individual (Zhu et al., 2016).

One of the major benefits of using fog computing in the system is the time that it takes for fetching and processing information from educational databases. Recent studies are looking at how to utilize capabilities across the Internet's edge to cloud data centers to support the latest fog computing and their requirements. Computational nodes near the edge could well act as filters, limiting the amount of educational data sent out to the Cloud, as well as computing power, generating educational analytics nearer to where data is used (Brogi et al., 2018). The competitive pressures force firms to adopt innovative strategies that leverage existing IT artifacts such as BDA, which enable novel business processes and productivity through data-driven decision-making (Müller et al., 2018). Alkhalil et al. (2021) agreed that because of competition and economic pressures, higher education systems have become gradually more absorbed in the application of big data analytics. Fog and Big data is a game-changer capable of changing the way businesses are run in various organizations for long-term competitive advantage (Muhammad et al., 2020). To foster high-quality higher education, processes must be goal-oriented, and the curriculum is relevant to discipline-specific subjects that comply with the needs of business and industry, and effective teaching, and learning norms (Alkhalil et al., 2021). Tulasi (2013) pointed out that higher education must employ novel methods of monitoring and improving institutional policies and student success. In regard to adoption of education analytics would require institutions to be more purposeful and intelligent in their use of data and evidence for administration, resource allocation, and decision-making.

Siemens and Long (2011) denounce that the value of education analytics encompasses its role in supporting technological advancements in higher education as well as supporting educators to improve learning and teaching. Learning analytics is critical for breaking through the fog that has engulfed more of higher education. Instructors, students, and administrative staff require a solid foundation to implement change. For instructors, having real-time information about performing students, including at-risk students, can also be a tremendous help in planning instructional methods. Analytics about one's performance compared to their colleagues or progress toward one's personal goals can inspire students. Eventually, administrative staff and decision-makers in education are experiencing challenges with tremendous unpredictability because of budget cuts and competitive pressures. Amor et al. (2020) recommended a fog-based secure e-learning scheme that realizes the confidentiality of data, well data control, and well no tampering. Data analytics improve student placement processes, accurate enrollment forecasting, and early warning systems by predicting and detecting students who are at risk of failing or dropping out, as well as increasing competitive advantages in higher education (Matsebula & Mnkandla, 2017). Fog computing is a cutting-edge technology that has the potential to improve daily operations in a variety of industries, such as education (Raman, 2019). Fog computing features that facilitate effective education analytics involve: (1) mobility reinforcement, including both IoT devices and affiliated fog nodes; (2) context-specific location awareness and low latency, allowing processing to occur near the source of data; (3) the heterogeneity and interoperability of various IoT, fog, and cloud nodes and telecommunications systems; (4) bandwidth savings by evading time-consuming data transfers to the Cloud when they are not required; and (5) spatial distribution, to perform decentralized decision-making using highly scattered nodes (Brogi et al., 2018).

8. Implementation challenges

Between IoT sensors or devices in the educational environment and the cloud's data centers, fog computing functions as a sort of middle layer, and is therefore fraught with difficulties (Wani, Batth & Rashid, 2019). Gedeon, Heuschkel, Wang and Mühlhäuser (2018) argue that the Fog System Service Level Agreement is one of them. A service level agreement (SLA) for fog systems does not exist. As a fog computing system spans several domains, a new and prospective service level agreement (SLA) will be necessary for the future. Most fog computing scenarios

include highly mobile individuals and devices, making data and application migration an enormous task. They move reactively fog instances, rather than proactively. Fog systems reduce capacity in the major network. The bandwidth limitation must be kept to a minimum with the addition of more devices. To handle IoT networks, current fog computing techniques are not scalable enough. Algorithms should be designed with scalability in mind so that they may smoothly integrate fog systems with IoT networks in the future.

The challenges of using fog computing and educational data analytics in higher education are broad and include both technical and organizational aspects (Hadwer et al., 2019). They relate the technical challenge to limited infrastructure and a lack of a comprehensive BDA framework in universities to manage and control processes, as well as data management and visualization. The organization's challenges include a lack of reputable institutional data governance processes and a driven strategy for successful BDA implementation. In the word of Jones (2019), the increased collection and use of personal and confidential student data raises additional privacy concerns. The major challenges in implementing fog computing and data analytics in education are data profiling, confidentiality, and learner entitlements in terms of individual behavior capturing (Klašnja-Milićević et al., 2017). Higher education faces challenges such as how to collect, analyze, store, manage, and present data to be used for determining various outcomes. Also, the increasing number of a student dropping outs and transferring from one institution to another. Alblawi and Alhamed (2017) describe some factors that determine student retention which include: (i) Out-of-institution factors such as health, finance, and social lifestyle; (ii) Academic Integration – for instance, student performance, satisfaction, academic experience, and classes or programs interest; (iii) Institutional Commitment encompassing finance, technological, academic assistant, proactive learning skills, and academic counseling; and (iv) Social Integration includes peer relationships, social support; and co-curricular activities.

9. Future direction for Education 4.0

We live in a world that is marked by volatility, unpredictability, complexity, and incoherence. The widespread use of IT artifacts and the COVID-19 pandemic denote disruptive changes (Wallner & Wagner, 2016). Today, organizations value data as a novel digital innovation. It is a requirement because of the rapid growth and evolution of long-term competitive advantage in the higher education system (Muhammad et al., 2020). Higher education is increasingly competing with practices to achieve the success of the institution, through the addressing of issues concerning education and retention, admissions, raising funds, and operating excellence (Lee et al., 2020). Therefore, education 4.0 is improving student performance and retention by progressively using academic and learning analytics. Alblawi and Alhamed (2017) exclaim the need to improve decision support systems used by education in the administration and management of learning processes and stakeholders for practical applicability and performance. A strong integrated learning analytics framework and distributed technology system are essential for academic authorities and advisors at educational institutions to make effective decisions about student retention rates and performance improvement strategies. Learning analytics can cut through the fog of uncertainty surrounding resource allocation, create competitive advantages, and enhance the quality and value of the educational experience (Siemens & Long, 2011).

Following the human-centered learning analytics method, based on a user-focused approach that spans over years in the realm of interaction between humans and computers, learning analytics should emphasize more on usage context and learner experience (Viberg & Grönlund, 2021). They itemize the following factors critical in the institution's alignment with educational data analytics, and technologies for insightful decisions: (i) Include students and examine their part in data usage; (ii) It is critical to involve both data analysts and teaching professionals to make sense of data and improve teaching and learning processes; (iii) The

development of educational data analytics is a necessity, to begin with, for the teaching and learning of problems and goals. Do not begin with data; (iv) Engaging in multiple data sources and types of data may be essential to seizure performance, students, learning perspectives, and procedures; and (v) Determining data requirements based on objectives and practice. Do not be satisfied with what is readily obtainable. West et al. (2016) articulated that to address a wide range of educational issues in the future, it is essential to connect academic staff to learning analytics as well as engagement in the spheres of: (1) Teaching and curriculum quality; (2) Student achievement; (3) The educational experience; (4) Duties and responsibilities related to teaching; and (5) Participation of students. Establishing data literacy in students and staff will be necessary to stimulate the culture change needed to move to data-driven planning and decision-making strategies in Education 4.0 (MacNeill et al., 2014). Research by Wallner and Wagner (2016) pointed out that to prepare our students for the future Education 4.0, we should consider: (i) For provision of a necessary range of educational processes in our universities, we can rely on self-organization at both the individual and collective levels; (ii) The complexities we encounter in the "external" world are mirrored in every part of our academic work; (iii) In order for self-organization to flourish, students must specify their own study objectives. We must also assist and guide the aforementioned process; (iv) Finally we can hardly contribute meaningfully to complexity with complexity.

Based on a study by Zhu et al. (2016), in the future, their expectations for smart education, with smart learning environments brought forward by educational data analytics and fog computing will reduce learners' cognitive load, allowing them to focus on context making and ontology development. Students learning experiences must be strengthened for students' growth. Learners can understand more adaptively and cohesively in smart learning environments, which may promote the improvement of students' learning individually and collectively intelligence. Besides that, better-customized learning support for learners raises their expectations. Education 4.0 need to be adopted, as well as learning interaction with various learning technologies, like the management of learning systems or courses with new tools, including intelligent early warning systems, that can monitor and predict many elements of learner's performance and behavior (Lee et al., 2020).

10. Summary, conclusion, and recommendation

The scenario that universities are generating massive amounts of educational data motivated the study. Because data volumes are increasing, few institutions have been able to capitalize on the benefits of information they collect daily through their core business of learning and teaching. With the fact that this institution is increasingly competing with practices to achieve the success of the institution, through addressing issues concerning education and retention, admissions, raising funds, operating excellence, and resilience over the pandemic. The biggest lesson for everyone else may be to adopt e-learning technology before a major disaster. Presently, we are compelled to engage in online virtual learning; things might be different if we had already perfected it. We evaluated appropriate fog computing and educational data analytics architectures; then investigated the opportunities provided by fog computing and educational data analytics; and summarizes the fog computing and educational data analytics implementation challenges, as well as emerging disruptions and future directions of these technologies in the education sector. The paper's findings showed the need for establishing data literacy in students and staff to stimulate the culture change needed to move to data-driven planning and decision-making strategies in Education 4.0. Similarly, the great potential of Industry 4.0 is originating in data and the effective use of newly gained opportunities and challenges. Besides, the architecture of fog computing has a lot of potential as a future education 4.0 strategy. Education 4.0 initiatives, strategic formulation, support of e-learning, and innovation are viewed as significant steps to transformation and change during a crisis, supporting the preventative measures and recovery of

higher education while trying to mitigate the impact on students and learning continuity. Pandemics have shown us that preparation is essential. Improving preparedness by utilizing the infrastructure of higher education (such as virtual learning and education resources) and human resources to solve the challenge of minimizing learning lost opportunity. Most institutions were prepared for and adapted to the crisis's effect by providing online classes. Already, the government and institution administrators are trying to implement measures and strategies to reclaim lost period through strategies of preparation, having to cope, and recovery, such as adjusting the academic calendar, implementing new learning styles, and continuing with virtual learning concurrently to physical learning to prepare for cases of emergency and to strengthen the system. The study identifies the need for preparedness amongst institutions to quickly adapt to changes in the environment and respond to new modes of delivery, such as virtual learning in pandemic circumstances – for example, COVID-19. Institutions must develop contingency plans (such as preparing, coping, and recovering strategies) in the event of a global epidemic or disaster. Higher education institutions should ensure resilience in their learning frameworks. Education 4.0 is a preferred learning style that aligns with the upcoming fourth industrial revolution; however, more research is required to determine educators' readiness for this transformational learning.

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Cyberdeviance in the Western Balkans and ICT-Media-Based Protection

Ilda Kashami

Mediterranean University, Tirana, ALBANIA
Department of Education, Communication and Competence Skills

Arjan Çuri

Mediterranean University, Tirana, ALBANIA
Department of Psychology and Sociology

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Abstract

The objective of the present paper research is to explore some of the basic aspects of the relationship between cyber-deviant behaviors and the role of border security and cyber security structures that exist in the cyber-digitalization process. The present article intersects diagonal aspects of deviant cyberculture and the role of media and police officers in the screening and prevention of criminal extreme acts. The research also provides a reflective view of consumerism that digitalization brings to the constant formation of adolescents. The implementation of misguided protection strategies and consumer safety from hazardous navigation directly affects the growth of passive and active criminality, qualitative changes in attitudes and behavior by pointing more towards antisocial deviance and crawling at the base ranging from national and regional security and internet addiction.

Keywords: cyberdeviance, Western Balkans, suitable structures, prevention, ICT.

1. Introduction

Technical and technological developments have made human life change a lot over the last decades. The development and refinement of technology in general and informative one, in particular, remain *cyberspace* as important part. The Internet can have a powerful impact on the development of value systems and shaping behavior.

The extraordinary increase in the use of computer technology and information, ICT, has brought a very wide range of exploration opportunities and vulnerability to exposure risk in the juvenile populations. Given its global and easy access character through connected devices, the internet has undoubtedly changed the socio-evolutionary form of the kind. ICT influences on fluid and crystallized intelligence are two important arguments in support of this premise.

On the hand, the alienization of technology has also provided new crime opportunities that can use the same advantages offered by these technologies to meet their objectives. The growing number of Internet users offers society the perspective to accelerate communications in

Correspondence: Ilda Kashami, Mediterranean University, Department of Education, Communication and Competence Skills, Tirana, ALBANIA.

everyday life to foster relationships, reduce transactions and spending, do business, increase access to information, and create a *global identity*.

On one hand, with the development of new opportunities for economic and social growth, the distribution of technology has changed the current picture of the concept of crime and introduced new challenges to the community, for micro and macro policy-makers as well as law enforcement officers. Cyberspace is constantly a major source of various illegal activities that include not only the emerging new types of crime, such as *hacking* or tracking through encryption or spyware programs but also poses a specific concern in the increment of the right for the protection of personal data and on the broader national security.

On the other hand, aggressive cyber-deviance has also led to an increased influx of traditional crime migration such as malicious exposure, trafficking, pornography and juvenile abuse, fraud, theft, etc. From the way we build an investigation profile, information sources, designs, stages, and the need for and assistance that gives a profile, we can construct data on the psychological profile of the author and the target group as well as with the stimulating behavior and psychological state of an individual in committing a criminal act (Agastra et al., 2017).

Undoubtedly, the fight against cybercrime requires strengthening either at the legal, o also at the criminal, or procedural level the instruments that allow the investigation and prosecution of persons who abuse ICT for c missing criminal acts. The present global dimension of cybercrime and the transboundary nature of information networks through ICT also brings the need for harmonization of legislative approaches and coordinated actions in the prevention and investigation of cybercrime at national, regional, and interregional levels (Gercke, 2006, 2009).

Although ICT networks are largely privately owned, the comprehensive cybercrime approach also includes the development of tools for effective cooperation with the industrial informatics sectors that promote the implementation of co-regulatory and self-regulatory methods.

Every actor in this multilateral environment interested in combating and preventing crime in cyberspace faces a wide range of challenges that may be related to general problems of the global nature of cybernetics or the unique character associated with the change of nature of the tasks, responsibilities, and functions of the parties used to act either in the real world or in the cyberspace. Police as a responsible and regulatory entity for maintaining and protecting public order, detecting, monitoring, and preventing crime is one of the protagonists in this scene facing a wide range of challenges (Walt, 2007) regarding the migration of traditional crime to the ICT environment and the emergence of new forms of criminal activity with a focus on the juvenile group (Quille, 2009; Kozlovski, 2005; Wall, 2007).

2. The role of law enforcement bodies in screening cybercrime: Issues and challenges

Existing approaches to combating crime in the real world are often not functional in cyberspace or may not be applicable in cases of ICT misuse for criminal purposes. It is therefore important to propose and develop a comprehensive approach to a hierarchy of micro and macro-structural to address the various aspects of cybercrime along with the unique challenges that seem new to law enforcement and investigative organs.

Such approaches should be taken into account in the development of strategies to combat crime in the virtual world:

- *The quantity and number of users*. The proliferation of internet usage in people's daily lives and as a way of doing business is dramatically increasing in the number of users in recent years. So in 2005, the number of internet

users in developing countries for the first time exceeded the number of users in industrialized countries (Special Immigration and Development Report, Information Society, 2005).

In our country, the data show that in 2019-2020, out of 175 cybercrime cases, 143 have the involvement of injured persons or 81.7% of cases, of which 51% are female. 11.8% of cases belong to the 14-18 years old or adolescence (Agastra et al., 2020).

From the global perspective, cybercrime is a form of crime that affects both sexes at the same time, but the long-term exposure of developing ages has already changed the focus of this target group. The increase in the number of users regarding the globalization of the communication network is a new challenge for the police and the cyberspace protection structures for at least two reasons: First, one of the weaknesses that pose an opportunity for criminals is the lack of understanding of individual online security along with the application of social engineering and privacy techniques (Rash et al., 2009).

Secondly, identity theft, *spam,* and *phishing* activities can be performed automatically (Berg, 2007; Ealy, 2003) without investing money and effort, it is therefore very difficult to automate the investigation process (Gercke, 2009).

- *Availability of means and information*. The Internet is designed as an open-access network to information and now extreme deviants can access sources of information or tools to commit cybercrime. Availability of software or computing software and devices that allow password tracing and theft, automation of cyber attacks, and the possibility of using search engines and robots for illegal purposes (Long, Skoudis & van Eijkelenborg, 2005; Dornfest, Bausch & Calishain, 2006), and guidelines on how to commit offenses have facilitated the development of crime both in the real world and cyberspace.

- *Difficulties in tracking offenders*. The various opportunities to conceal identity in ICT networks and the different means, ways, and approaches to access anonymous, surfing, and social networking links complicate the work of law enforcement agencies to track and monitor the offenders (Lovet, 2009).

Opportunities for the use of proxy servers, anonymizers, unprotected public wireless networks, and the use of anonymous communication services have been largely exploited by cybercrime. When the criminal activity involves different states, it is very difficult to investigate such acts that include both the international aspect and the hidden identity concern.

- *A lack of control mechanisms*. Since its first discovery, in the 1960s, the Internet was not designed to be vertically led. The horizontal structure and decentralized network model hampers control over online activity and make it difficult to investigate crimes committed in cyberspace. Co-regulatory and self-regulatory approaches and cooperation with infrastructure operators as well as with internet service distributors are needed when dealing with the problem of ICT misuse (Sofaer & Goodman, 2001).

- *The lack of boundaries in the cyber-space and the international aspect of cybercrime*. Penology and criminal investigations are considered a matter of national sovereignty in international law and security, while the protocols applied to the transfer of data on the internet are based on the optimum data transfer, so the data transfer processes pass on more than one country (Putnam & Elliott, 2001; Sofaer & Goodman, 2001; Roth, 2005).

Furthermore, because cyberspace has no boundaries, criminals, and victims can be found in different countries or even on different continents, requiring a multitude of cooperation by all countries involved in an international investigation. While the formal requirements for cooperation take up time, the investigation process can often be faced with obstacles (Gercke, 2006; Sofaer & Goodmann, 2001), data and tracks are very delicate and may disappear shortly after the crime has been committed. States, which have no cooperation framework for cybercrime issues, may become a safe shelter for offenders who want to hinder the investigation process. Moreover, the internet can motivate an individual deviant to be physically present in one state while committing a crime in another state.

The role that police and law enforcement agencies must play in combating cybercrime with a focus on juveniles is endangered by all the above-mentioned issues. Not only cybercrime investigation is complicated, but cybercrime investigation policing may also be hindered. It is very difficult for police agencies to initiate investigations mainly because of the low visibility of this crime and the lack of reporting by the victims (Lovet, 2009). The phenomenon of non-declaration of cyber-crime, as well as many other phenomena of the social aspect, may occur for various reasons such as the unwillingness of commercial entities and financial companies to report to the police a certain account or threatening injurious behavior, the negligence of individuals involved in cyberbullying in ignoring these issues, the denial and the unknowledge that cybercrime is true and may have involved the individual and at last the lack of trust in police structures (CSI & FBI, 2004; Wall, 2007). Due to the low level of reporting, the lack of resources, and reporting to law enforcement agencies, these structures are not able to investigate and prospect more than a "small" fraction of what is happening in cyberspace (Vogel, 2007).

The use of the internet and ICT technologies, provide researchers the opportunity to create low-impact income for a specific victim as one of the most significant challenges for the police is the justification of the violation of public order and the opening of investigation procedures.

Differences in criminal acts and offenses, cultural differences in the seriousness of the crime, and great discrepancy over what should be considered illegal, place police units among those most affected units by these contemporary evolution challenges

Finding a fair balance between investigative power and human rights, the application of preventive measures and the preservation of the nature of open access to the internet remain serious problems of the police units in cyberspace. The lack of control mechanisms, during the initial development of the internet and network architecture, requires the development of cyberspace policing tools, the mechanisms for monitoring ICT networks, of the prevention and detection of illegal activities on the Internet and the net space. Likewise, the initial idea of the internet as a space for open discussion, exchange, and sharing of opinions and viewpoints as well as the free flow of information should not be hindered, so, the challenge is also to maintain the network opening and its developing process along with social developments

According to the National Central Bureaus of Interpol (NCB) published in April 2021, 87% of international offices had dedicated cybercrime units but lacked the capacity for conducting a high-profile incident (Interpol, 2021).

Thus, another necessary and crucial step is to develop effective mechanisms of human resource use and the capacity to strengthen national and international cooperation mechanisms.

To enhance the effectiveness of response against cybercrime with a focus on juveniles, studies of the Senior Intelligence Agencies and Crime Prevention have suggested:

- Creating a Task Force working team within the law enforcement and crime enforcement structures with a priority on cyberspace crimes;

- Increasing training capacities for police officers for the psychopathological social structures of the age of the child, the target group with the highest incidence of cyber victims;
- Increase access and cooperation approaches of police officers with the community they are responding to, with educational institutions, Internet service centers, and private sector operators;
- Developing human resource capacities trained and certified for aspects of database creation, mapping of areas and communities with higher risk, and Cyber Laboratory for Priority Care and Examination;
- Strengthen legal, civil, and criminal penalty acts for abusers and those identified as having a high potential for cyber deviance;
- Coordination of structures at the local and central level for the prevention of cybercrime with a target of juveniles;
- Coordination of the media, information agencies, and social media to foster their space usage against deviant and extreme-trigger posting, commentaries, and actions.

The sharing of responsibility and cooperation between the police, community, state, and private service sectors seems to be the most effective way of dealing with cybercrime at local and national levels (European Commission and Parliament, Security Council and Regional Committee, 2022). As revealed in several studies and publications, such cooperation with co-ordination and self-regulation can yield even better results than mere enforcement of criminal *law per se* (Sieber, 2010).

3. Conclusions

The fight against cybercrime needs a comprehensive approach involving the development, application, and revision of technical, legal, structural, and social measures, with the construction of specified organizational structures to address this global-scale problem as Central Bureau of Investigation in Cybercrime and Data Protection Privacy.

Moreover, cybercrime treatment requires effective national and international coordination about cybercrime issues that need to be built on the coordination of local and national policies (Report of WGIG, 2005). The approach of many participants, including the community, pre-university, and university education institutions, defense and law enforcement agencies, social protection structures, etc., implemented at the national level should be coherent with the regional and international developments where the harmonization of tools for treating cybercrime has shown positive and efficient results. Macro-social efforts to establish policies and legal coercive measures should necessarily be based on respect for the Human Rights and Freedom Declaration (Declaration of Human Principles and Rights, art. 11, 2003) as well as technical and economic expertise, civil society readiness, and ease of interaction with organizations and support structures that develop common application standards. Despite the challenges faced, police and juvenile protection units in the regional states of the European Union and especially between neighborhood countries, as one of the key parties in cybercrime, can act as a central encouraging model for building links between different actors, developing cooperation and developing national and international approaches to address the problem ICT of misuse and harm.

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