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Motivation and ICT in Secondary School Mathematics using Unified Theory of Acceptance and Use of Technology Model

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ABSTRACT

Mathematics is a special subject that cut across every other subject and every aspect of human life and serves as a clue in solving real-life problems. Teaching mathematics with Information and Communication Technology (ICT) materials might bring tremendous progress in the field of mathematics learning. This is activity-based which makes all students in mathematics class participate fully and contribute to learning. The opinion of secondary school students on ICT use, what is expected from them, and the motivation encountered in mathematics class was investigated. Three hundred (300) secondary school II learners were selected randomly from six secondary schools in Educational District II in Lagos state. The instrument used was based on Mathematics Teaching with ICT (MTICT), this was divided into different sections Student Perceived Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, and Student Motivation. The data were analyzed with percentages and mean. From the result, the use of ICT in teaching secondary school mathematics enhanced the performance expectancy, create more motivation and the social influence from peers, friends, colleagues, and society members contribute immensely to the encouragement of the student in ICT use for studying mathematics. Therefore, ICT should be used in secondary school mathematics teaching.

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1. INTRODUCTION

Mathematics is useful in human life in such a way that it forms the numerical and calculation part of human lives. There is no way to get through a day without using mathematics especially in solving problems. Mathematical knowledge provides the tools to make life easier. It is the cornerstone of the development of any nation. Man's ideas and conclusions can only be interpreted with the use of mathematical calculations. Mathematics is about facts and relationships, also with space problems. Mathematics also deals with the relationship between magnitudes (Passolunghi & Lanfranchi, 2012).

Mathematics simplifies and arranged the scientific abstract concepts and information from particular objects and phenomena. The high the technology developed the greater the mathematical skills required. The world is now a global village, computer knowledge is required to face the world challenges that lead to progress and development. Mathematics has been the loom upon which the fabric of the universe is been built, the more complex a society is, the more complex mathematical knowledge required. Mathematics should be embraced worldwide since it is an asset to all knowledge.

Mathematics is an inseparable element in any form of engineering course. Every aspect of engineering as a course found its basis in mathematics either in form of design, construction, or calculation of the needed materials. Generally, mathematics contributes to engineering to describe the complex systems that can be simulated by computers. The means of finding optimum designs, features, and operating conditions can be varied in simulation. The wrong calculation can lead to the hazard of different forms such as the collapse of any form of structure like bridges and buildings, especially in civil engineering.

Mathematics teaching and learning should involve the active participation of students (Akinoso, 2016) which is embedded in the use of ICT. Using ICT for instruction will arouse the students' interest, attract effective contribution from learners, provides enabling environment for learning, results in mastery of the contents, and improve learners' results in mathematics. Meanwhile, some secondary school teachers kicked against the use of the tools like scientific calculators, android phones, iPad, and other ICT tools in mathematics class. These tools will contribute immensely to mathematics learning, boost the interest of the learners, and improve the learners' performance. ICT use will also motivate learners in learning mathematics, and minimize the abstract nature of mathematics.

The benefit of teaching is to make students become useful members of society in an uncertain, and complex world (Akinoso, 2015). The interaction and communication degree between learners and the teachers determine the learning success of any subject. Experience in education and training in various skills and knowledge project human beings in facing life demands. The environment should be modified to meet the needs and desires of society.

This can be done through quality education in every area of study most importantly in mathematics to meet people's needs. The quality of teachers is very essential in student achievement to meet students' needs. Whatever content is taught, whichever environment the school is situated, and whatever kind of study is not given to teach the valuable role of teachers cannot be overemphasized in any educational system. To prepare for the future, learners must be empowered to be active in arranging the learning process.

To achieve quality education the impact of information and communication technology should be put into consideration and used in the school system. Tremendous progress was brought to the field of education with ICT use. ICT has changed the teachers' and learners' roles with the revolution in the process of learning. To meet the needs and challenges of this present age, ICT is imperative in human life, every society needs to adjust.

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Information and communication technology have changed many aspects of an individual's way of life. More knowledge of ICT is required to meet life's demands. Every activity is carried out online including health, commodity purchase or shopping, education, business, church activities, and other crucial activities. The world has become a global village in which all information and activities in different parts of the world can be watched clearly, learn from, criticize, and submit additional opinions without stress.

The technology influence transformed and brought a rapid technological, social, political, and economic transformation to every society. ICT is being used successfully in developed countries but due to the cost and inadequate available resources, its use is limited in developing countries (Ajayi & Ekundayo, 2009). The teachers as suggested by (Akinoso *et al*., 2017), must not rely fully on the traditional way of teaching but allow innovation in the teaching strategies adopted. The teachers should enhance the skills and ICT basic knowledge to ease the technology usage.

Also, the ICT tools including computers and other facilities required should be made available in classrooms, central computer laboratories, libraries, teacher's planning room, and on mobile carts to move from one classroom to the other. The mere availability of powerful, globally-connected computers is not sufficient for the learning of subjects like mathematics and science that pose conceptual difficulties but, identification of the advanced ways to design and use them must be considered to advance learning. ICT forms part of human daily existence, the more advance the human needs the more ICT knowledge is required. These needs triggered the integration of ICT into different subjects in the curricula.

Educational opportunities can be provided for people with no direct access to education due to the scattered population in rural settlements, old age, and others with ICT use. In using technology for the educational delivery physical presence of the teachers and learners in a location is not compulsory. Virtual learning is in existence to supplement physical teaching. Mathematics can be learned virtually without issues through the use of ICT if the instructor is good at the use of the ICT tools. In mathematics and science education, innovation enables learners to appreciate electronic teaching. Stakeholders were provided opportunities with technology and mathematics innovation to communicate through email, chat, and providing access to current information (Yusuf, 2005).

ICT consists of the used techniques to manage information and knowledge, techniques of teaching mathematics, and hands-on manipulation in learning mathematics. Manipulative provides concrete ways for students to simplify and bring meaning to abstract ideas in mathematics. This assists students in learning new concepts and these new concepts are been related to what already learned.

The use of ICT assists students to see mathematical relationships, and tactile and visualizing the models that assist in developing the students' understanding and reducing the abstract level of the concept to real object to visualize. ICT assists the student to learn due to the interest possessed in using the computer. Students nowadays live in a world where information communications technology plays a substantial role in human lives. Students nowadays have computer knowledge, are deeply involved in usage, possess rich digital experiences, and are influenced by new technologies.

Mathematics teaching and learning should not be in memorization of the facts by learners but to master the fact with a thorough understanding as a result of the use of a learner-centered approach. Active learning might help increase the students' performance in mathematics class. The use of technology that engages students in more activities can change the nature of mathematics and make the students experiment, investigate and solve

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problems that bring depth to learning. Many benefits are attributed to ICT use in mathematics class including improvement and awareness of the expectation from learning, improving the learners' attitude toward learning (Gasaymeh & Qablan, 2013), motivation improvement to learning (Hanafi *et al*., 2017), and enhancing the students' performance in mathematics.

The construct put into consideration in this study include expectation which means individuals believe the degree that which technology is used will result in a performance gain. Students believe and think about the use of ICT in learning become important. There must be ways to convince or for the students to be convinced after being put into practice the ICT application in learning, mathematics in particular. Practice makes perfect, when students try learning mathematics with ICT and discover the bofefits on their performance the students will then realize the importance of ICT in learning.

Motivation is another variable considered in this research which is the desire to learn. The desire cannot just be made without interest or in other words curiosity. Interest forms the basis for motivation. The interest in learning any subject can be developed through the mode of teaching.

Teaching mathematics in the abstract cannot boost the student's curiosity and this will affect the motivation towards learning. Concept motivation according to Abramovich *et al*. (2019) is a teaching strategy through which using the curiosity of students as a pivot, a new concept introduction is justified by using it as a tool in application to solving real problems. It is imperative to improve students' curiosity in mathematics learning with the aid of ICT to contribute to the desire and motivate learning.

The Unified Theory of Acceptance and Use of Technology (UTAUT) model was used in this study. This is the model formulated by Venkatesh *et al*. (2003) which consists of four main concepts, performance expectancy, effort expectancy, social influence, and facilitating condition referred to as potential constructs to explain the perception of the user and acceptable behavior. The dependent variables influenced by independent variables' behavior and usage are the four main concepts. A critical predictor of technology use is behavioral intention (Venkatesh *et al*., 2003). The four major constructs were used in this study to examine how students perceive ICT use in learning mathematics.

The age and gender of the students were also considered in this study to know whether they have any influence on ICT use in secondary school mathematics classes. Active learning is an important issue in mathematics class due to its importance in learning other subjects. This active learning must be put into consideration to make mathematics teaching interesting, engage all learners, and entails learning. Information and communication technology have a lot of materials that make students active and make teaching interactive. The ICT use in mathematics teaching might increase the learning of mathematics and improve the students' academic performance. This study seeks the opinion of students on motivation acquired with ICT use through UTAUT in learning mathematics.

The study is to examine the expectation and how motivated the use of ICT is to secondary school students in learning mathematics in Lagos State. Also, to determine the social influence and effort expectancy on the use of ICT in learning mathematics.

Research questions are

(i) What is the performance expectancy of students in mathematics with the use of ICT?
(ii) How do students perceive the effort expectancy with the use of ICT for learning mathematics?
(iii) How do students perceive the social influence of the use of ICT for mathematics learning?
(iv) How do students perceive the facilitating conditions on the use of ICT?
(v) How motivated are students in learning mathematics with ICT?

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2. THEORETICAL FRAMEWORK

This study adopts the UTAUT model a technology acceptance model generated by Venkatesh *et al*. (2003) in-user acceptance of information technology which explains the intentions of the user to use an information system and subsequent usage behavior. The acceptance of an information technology degree was explained in this model. The four concepts in the model are Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), and Facilitating Conditions (FC).

These are the four potential constructs to explain user perception, expectation, motivation, and acceptable behavior. As explained, the four concepts are independent variables that influence the behavior and usage of the dependent variables. Meanwhile, gender, age, experience, and volunteers of system use influenced the dependent variables indirectly through the four main concepts.

(i) **Performance Expectancy.**
This is the degree to which the beliefs of individuals that technology use will result in a performance gain. It is designed to moderate the influence on the behavioral intention of gender and age. This present study was designed to seek the students' opinion on this construct that is, the expectation of mathematics learning with ICT use.

(ii) **Effort Expectancy: Effort expectance is the technology's ease of use.**
The degree 'of ease of use associated with the use of the system is the effort expectancy (Venkatesh *et al*., 2003). Effort expectancy is to moderate the behavioral intention influenced by gender and age, and experience.

(iii) **Social Influence.**
This is the extent of an individual's beliefs about others who believe they should use the technologies**.** It is the degree of perception of individuals on others' belief as important that he or she should use the system.

(iv) **Facilitating Conditions.**
This is the individual who believes in organizational and technical infrastructure exists to support the use of the system. In the use of ICT in the classroom, are there technical infrastructures on the ground to make the system work? This is a critical aspect and the conditions that must be satisfied for the proper usage and to make ICT work in the classroom.

Age, gender, education, and voluntariness are variables also included in the model. In the UTAUT model, the four major factors affect directly the behavioral intention, along with facilitating conditions. The interaction effects of each performance expectancy, effort expectancy, and social factors with each age and gender; the experience interactions with each of effort expectancy and social factors; and voluntariness interaction of use and social factors on behavioral intention are also included.

Venkatesh *et al*. (2003) reiterated further that interaction effects of age and facilitating conditions; experience and facilitating conditions on behavior exist. Some developed countries embraced the use of ICT and integrated it into subject teaching. Information communications technology will enhance the way of teaching and open many new opportunities for mathematics instructors and learners to explore and improve their knowledge for creativity.

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Depending upon the philosophical orientation behind the teaching and learning activities, different teachers have different perceptions of the use of ICT. But moreover, many teachers accept that the use of ICT enables students to produce many examples and support their work. Also, teachers consider that the ICT tools and resources used could support teaching and learning activities. So, by using ICT in mathematics class, students visualize mathematics concepts and their applications which helps to change students' beliefs and opinions about mathematics.

The engineering lecturers' performance expectancy in digital library use in South-west Nigeria universities indicated that high relative advantage, intrinsic motivation, and extrinsic motivation were possessed by the lecturers. Mtebe *et al*. (2016) reported that out of the factors influencing multimedia use to enhance the content in Tanzania secondary school, others except performance expectancy had a significant effect on teachers' acceptance and developed content use.

Bagon and Vodopivec (2016) concluded that ICT use motivated students in learning and the students to have a positive attitude towards such teaching methods. Attuquayefio (2014 concluded that ICT use is statistically insignificant on social influence. Venkatesh *et al*. (2003) and Attuquayefio (2014) concluded that Effort Expectancy is the only variable whose effect significantly influences students' behavioral intention to use ICT available for learning.

3. METHOD

The study employed a descriptive research design. All senior secondary school students in Lagos Education District II form the population. A simple random sampling technique was adopted in sample selection. For the selection of one educational district out of six districts in Lagos State, a simple random technique was used. All three zones in education district II, Ikorodu, Kosofe, and Somolu local government in Lagos State were included.

Six schools were selected randomly from the three zones. An intact class selected from each school forms the sample size of 300 students. A questionnaire was used to collect data. The instrument consists of two sections based on socio-demographic data of the students, and numbers of items of strongly agree, agree, disagree, and strongly disagree which attract the following score respectively for positive questions 4, 3, 2, and 1 but was reversed for negative questions.

The reliability of the instrument used was ascertained by administering the researcher-design questionnaire to a school outside the district, precisely a secondary school in district III. However, Cronbach Alpha was used to obtain the reliability coefficient. The co-efficient obtained was 0.86.

The instrument used was based on Mathematics Teaching with ICT (MTICT), this was divided into four sections: Social Influence (PSI), Perceived Effort Expectancy (PEE), Perceived Performance Expectancy (PPE), and Perceived Motivational Level (PML). The descriptive and inferential statistics of percentage and mean were used to answer the research questions using Statistical Package for Social Sciences (SPSS) version 20.0.

4. RESULTS

From **Table 1**, 46% of the respondents were male while the remaining 54% were females. The table shows that 33% of respondents were within the age range of 13-14 years, 39% were between the ages range of 15-16 years, 16% were between the age range 17-18 years, and 12% indicated 19 years and above.

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Table 1. Summary of demographic students' attributes.

Variable	Classification	Freq.	%
Gender	Male	137	46%
	Female	163	54%
Age	13-14yrs	48	33%
	15-16yrs	117	39%
	17-18yrs	99	16%
	Above18yrs	36	12%

4.1. What is the Performance Expectancy of Students in Mathematics with the Use of ICT?

The performance expectancy was examined and the result shows that the use of ICT in teaching mathematics will result in high performance. The average mean score of the student perception on performance expectation is 26.81 out of the total mean score of 40. This is equivalent to 67% which is high enough to conclude that the use of ICT as an expectation improves the students' performance in mathematics (see **Table 2**).

Table 2. How students' perceived performance expectancy of the use of ICT.

S/N	Items	Mean
1	I believe that ICT knowledge will enhance excellent performance in mathematics	2.83
2	Students with access to ICT perform better in mathematics.	2.72
3	The use of ICT help students performs better in internal and external mathematics examinations.	2.79
4	I understand mathematics concepts better because of my knowledge of ICT.	2.68
5	I believe that using the internet with a computer aids my knowledge of mathematics.	3.07
6	ICT is meaningless to me, without it I can perform better in mathematics.	2.34
7	I will perform better in mathematics with the knowledge of ICT.	2.80
8	The use of ICT will make mathematics more difficult to understand.	2. 40
9	I believe that the curriculum is not well developed to encourage ICT use in mathematics.	2.33
10	The use of ICT gives me opportunities to get high grade	2.85

4.2. How do Students Perceive the Effort Expectancy with the use of ICT for Learning Mathematics?

For the effort expectancy in the use of ICT, the result from the table shows that concluded that ICT is very easy to use, ease for mathematics learning, and easy to operate with a mean of 23.07 covering 72.1% of the total mean of 32. This answered research question 2 that the student with the expected effort found ICT easy to use (see **Table 3**).

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Table 3. Students perceived effort expectancy (SPEE) in the use of ICT.

S/N	Items	Mean
1.	I believe that interaction with ICT is very easy.	2.77
2.	I found ICT very easy to operate.	2.84
3.	ICT application in solving mathematics problems is easy for me.	2.90
4.	I believe I can use ICT very well	2.89
5.	I believe that ICT is an additional advantage for me to employ to proffer solutions to some difficult mathematics concepts.	3.01
6.	I expect that ICT is easy to operate and assists me a lot in mathematics.	2.99
7.	ICT eases mathematics learning.	2.88
8.	Without ICT mathematics learning is not complete	2.79
	Total	**23.07**

4.3. How do Students Perceive the Social Influence of the Use of ICT for Mathematics Learning?

On social influence of the use of ICT, the result in **Table 4** displays the mean value of 26.5 which is 66.25% of the total mean of 40. This result indicated that the social influence on the use of ICT contributes immensely to the encouragement and success of the use in learning mathematics.

Table 4. Students' perceived social influence (SPSI) of the use of ICT.

S/N	Items	Mean
1	The school administration encourages and supports the use of ICT in learning.	3.12
2	My peers encourage me with the benefits of the use of ICT in learning mathematics	2.78
3	Those who use sophisticated phones to practice after classroom lessons usually perform better in mathematics and encourage me to do the same.	2.88
4	My friends encourage me to always put into practice the ICT use and learn better.	2.68
5.	Nobody encourages me to embrace the use of ICT	2.25
6.	Society encourages ICT use in schools.	2.66
7.	My interest in the use of ICT cannot be defined	2.30
8.	ICT use might be of help but I am not motivated to the usage.	2.45
9.	I have a greater awareness of the use of ICT.	2.98
10.	I am not that curious about the use of ICT	2.40
	Total	**26.5**

4.4. How do Students Perceive the Facilitating Conditions on the Use of ICT?

The facilitating condition of the ICT was addressed in **Table 5**. The mean of 26.07 amount in 65% of the total mean of 40 was realized. It was then indicated that ICT facilities are available in the schools.

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Table 5. Students' perception of facilitating conditions of ICT in mathematics class.

S/N	Items	Mean
1	ICT resources are available in my school.	2. 56
2	Every tool needed for ICT use in mathematics is available.	2.23
3	I have adequate knowledge of using ICT.	2.67
4	If I have issues with the use of ICT, there is standby assistance put in place.	2.45
5	Every available facility for the use of ICT is users' friendly and can be used without stress.	2.42
6	ICT facilities are not adequate in my school.	3.20
7	ICT and its resources are adequately available but under close monitoring which affects accessibility.	2.54
8	Though the facilities are available but rarely used by students.	2.63
9	No ICT in my school not to talk of other facilities in conjunction with the use	2.60
10	ICT is used once a while for mathematics due to a lack of power supply	2.77
	Total	**26.07**

4.5. How Motivated are Students in Learning Mathematics with ICT?

The result in this **Table 6** shows that the students are highly motivated in the use of ICT in learning mathematics with the mean score ($\bar{x}$ = 25.62) given 71.2% out of the total mean of 36. The result is high enough on motivation and indicated that the ICT use motivates student learning.

Table 6. How students perceived motivational level (PML**)** gained from the use of ICT.

S/N	Items	Mean
1	I am always happy each time my teacher uses ICT in teaching mathematics.	3.23
2	ICT helps in solving some of my mathematics assignments.	2.87
3	I feel highly motivated by ICT which makes mathematics more fun and enjoyable.	3.10
4	I learn mathematics better whenever my mathematics teacher uses ICT.	2.91
5	The availability of ICT infrastructures will motivate my performance in mathematics.	2.68
6	ICT makes mathematics more difficult to learn as the subject.	2. 30
7	I prefer normal classroom teaching without ICT.	2.41
8	I am always excited about solving mathematics problems each time I have access to ICT and internet facilities.	3.12
9	I concentrate fully in mathematics class when ICT is involved.	3.00
	Total	**25.62**

5. DISCUSSION

The results revealed that information and communication technology used in teaching secondary school mathematics will enhance the student performance expectancy. This result is consistent with the submissions of the performance expectancy of engineering lecturers in digital library use in South-west Nigeria universities indicated that high relative advantage, intrinsic motivation, and extrinsic motivation were possessed by lecturers. The result of this

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study contradicts the submissions of Mtebe *et al*. (2016) who reported that out of factors influencing multimedia use to enhance the content in secondary school in Tanzania, others except performance expectancy had a significant effect on teachers' acceptance and developed content use.

The ICT use in learning mathematics at the senior secondary enhances effort expectancy. As concluded from the analysis above effort expectancy in ICT use motivates mathematics learning at senior secondary school. This result agrees with the original assumption by Venkatesh *et al*. (2003) and with the findings of Attuquayefio (2014) who concluded that Effort Expectancy is the only variable whose effect significantly influences students' behavioral intention to use ICT available for learning. This result contradicts Birch and Irvine's (2009) research results.

This result indicated that social influence on the use of ICT contributes immensely to the encouragement and success of the use in learning mathematics. It was established that most students believed that ICT use in teaching senior secondary school mathematics will enhance the performance in mathematics with the opinion of the people in the society. On facilitating condition, it was established that enough facilities in terms of humans and materials are adequately available for the benefits of ICT use in mathematics. This indicated that ICT facilities are available and properly used to facilitate learning.

Information and communication technology used in teaching mathematics in secondary school creates more motivation for studying and learning mathematics. The results of this study are in agreement with Bagon and Vodopivec (2016) findings who concluded that ICT use motivates students in learn

ing and allows the students to have a positive attitude towards such teaching methods. Motivation is related to the learning process and achievements. The understanding students' behavior depends on knowledge, skills, and abilities the cognitive factors, and the motivational factors.

This is the reason why when studying the ICT use in learning motivation should be taken into account. Also, the study showed that motivation for learning with educational technology is high in students with learning disabilities, moreover, in line with the Papastergiou (2009) results. The ICT use in teaching senior secondary school mathematics helps socially influence the student in studying mathematics according to the results of this study. This result supports Birch and Irvine (2009) findings but contradicts the findings of Attuquayefio (2014) that the ICT use is statistically insignificant on social influence.

6. CONCLUSION

This study concluded that ICT use enhanced mathematics learning in secondary school. The ICT use in teaching secondary school mathematics positively affects performance expectancy, motivational level, social influence, and students' effort expectancy. Therefore, ICT inclusion should be encouraged in secondary school mathematics classes. The school should be well equipped with information and communication technology materials and mathematics teachers should be given adequate training for effective handling and use of the materials to improve the performance of students in mathematics as a core subject.

7. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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