

Efficacy of Assistive Technology for Improved Teaching and Learning in Computer Science

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Abstract: This study examined the efficacy of assistive technology (AT) for improved teaching and learning in computer science (a case study of an inclusive educational system). Two (2) hypotheses were formulated and tested for this study. A descriptive survey method was adopted for this study, the population of this study comprises all Students with special needs and all teachers teaching at Durbar Grammar School, Oyo, Oyo State, Nigeria. A purposive sampling technique was used to select twenty (20) respondents (teachers) and all the Students with special needs were involved (40). A structured questionnaire of two sections (sections A and B to be answered by the Teachers and the Students respectively) which was validated and tested for reliability was used; a reliability coefficient of 0.81 was obtained. Simple percentages and the Chi-square statistical method were used to analyze the collected data which was tested with this study's hypotheses. The results of this study revealed that AT is capable of improving the teaching and learning of computer science for Students with special needs in an inclusive education if AT is allowed to play its role. It was also discovered that both the teacher and students with special needs were exposed to very little AT and there was no periodical training programme for both the teachers and the students with special needs on the use of AT which has affected their teaching and learning ability. This paper, therefore recommends that a periodical training programme on the use of AT be organized by all the stakeholders in inclusive education for both the students with special needs and all the teachers teaching them.

Index Terms: Assistive Technology, Efficacy, Inclusive Education, Learners with Special Needs.

1. Introduction

From the literature, evolving technologies have revolutionized our daily living and the educational sector is not left out, most especially, for students with disabilities. Assistive technology refers to the devices and services that are used to increase, maintain or improve the capabilities of a student with a disability. Inclusive education is when all students, regardless of any challenges they may have, are placed in age-appropriate general education classes that are in their own neighborhood schools to receive high-quality instruction, interventions, and supports that enable them to meet success in the core curriculum.

Over the past decade, evolving technologies have revolutionized the way we do business, communicate, make war, farm and provide medical treatment. New technologies are also transforming education, and in no domain more dramatically or successfully than in the education of students with disabilities [8]. Student with special needs includes hearing and speech impaired, visually impaired, physically and health impaired, learning disability, communication and behavioural disability, gifted & talented as well as intellectual disability. Technology has played and continues to play an increasingly significant role in the lives of people including people with special needs.

Technology is more than computers and networks. Technology has always been part of the learning process from its inception, whether it was printed books (hard copies), writing instruments, or audiovisual media. Technology includes devices and procedures/methods that make daily life activities accessible and enjoyable to people with special needs. Dell et al. (2012) stated that assistive technology refers to the devices and services that are used to increase, maintain or improve the capabilities of a student with a disability [1]. Guilford (2003) opined that the teaching and learning process summarized six areas of how technology generally can benefit teacher and the student: technology can make education more productive, technology can make education more individual, technology can give instruction a more scientific base, technology can make instruction more powerful, technology can make learning more immediate,

and technology can make access to education more equal [9]. The last point of Guilford (2003) on how technology generally can benefit teachers and students buttresses the fact that assistive technology can promote inclusive education. That is, technology can make access to education more equal.

Technology can make students with special needs and students without special needs have access to the same education in the same environment. Joseph (2013) stated that technology helps students with disabilities on many different levels. It can help them accomplish tasks like Master grade-level content. Technology presents the material in different forms (visually, auditoria etc), and improve writing and organizational skill [17]. Ufford (2007) found that assistive technology is a device or service that helps persons with disability in their daily activities [14]. Ufford (2007) also states the kind of learning problem that assistive technology can address which includes listening, math, organization, memory, reading as well as writing problems [14]. Ufford (2007) further stated that “assistive technology” has usually been applied to computer hardware and software, and electronic devices [14]. However, many Assistive Technology tools are now available on the internet such as Abbreviation expanders, alternative keyboards, audiobooks and publications, graphic organizers and outlining, information/data managers, optical character recognition, personal audio listening system, portable word processors, proofreading programs, speech-recognition programs, speech synthesizers/screen readers, talking calculator e.t.c

Inclusive education on the other hand is when all students, regardless of any challenges they may have, are placed in age-appropriate general education classes that are in their own neighborhood schools to receive high-quality instruction, interventions, and supports that enable them to meet success in the core curriculum [19, 21]. Effective inclusive education occurs primarily through understanding, accepting, and attending to students’ individual differences and special needs. Cushner et al. (2012) opined that inclusive education refers to the practice of including another group of students in a regular classroom; students with physical development or social-emotional disabilities and those with chronic health problems [15]. Inclusive education is a process that implies not only the integration of children with disabilities in mainstream schools but also the curricula adjustment in order to satisfy the needs of every child, no matter the level of his psychological development, physical development, social development, ethnic background or family [4].

The inclusive education motive principle is to ensure that, all students (students with and without special needs) feel welcomed, properly challenged, and sustained in their ability since disability is not inability. To achieve this motive principle, assistive technology needs to play its role. Assistive technologies (ATs) are devices or services that offers much potential to improve the lives of persons with special need. These technologies range from sign language and hearing aid for the deaf, talking calculators, talking wristwatches, talking computer, Kurveil reading machine which is a small computer that converts printed document to speech, and portable braille recorder which allows blind people to record braille onto tape cassette and play them on the machine reading device board, software tutorials, data bank, computer game, wheelchairs e.t.c. which are designed to assists persons with a different kind of special needs more easily in the world.

The school and classroom operate on the premise that students with disabilities are as fundamentally competent as students without disabilities. Therefore, all students can be full participants in their classrooms and in the local school community. Much of the movement is related to legislation that students receive their education in the least restrictive environment (LRE). This means they are with their peers without disabilities to the maximum degree possible, with general education, the placement of the first choice for all students [19].

It has been observed that the majority of the newly admitted students with special needs at Federal College of Education (Sp.), Oyo that passes through the inclusive educational system during their secondary school days lack the technical know-how of the majority of the assistive technology devices. Their academic performance in computer science in their first instance in College is usually poor when compared with their counterpart (students without special needs). Edyburn and Gersten (2007) reported that only a few researchers are conducting systematic, well-designed research that can lead to confident conclusions on how the use of assistive technology affects learning [7]. It is, therefore, necessary to investigate the efficacy of assistive technology (AT) for improved teaching and learning of computer science in an inclusive educational system with the use of well-designed and structured research hypotheses that must be tested for validation.

2. Related Works

Technology has unlimited prospective in providing the ability to access the general education curriculum for learners of all kinds [10]. Saleem et al. (2019) explore the training facilities provided by special education schools to their students with visual impairment and their teachers in the field of assistive technology and reported that the majority of the special schools used for their study were not providing any training for the students with visual impairment and their teachers regarding the use of assistive technology and software training [18]. Liman et al. (2015) researched how assistive technology can be used effectively as part of the educational programmes for students with learning disabilities in an inclusive classroom setting by investigating the teachers’ perceptions about the use of assistive technology and found that the use of assistive technology determines the success of students with learning disabilities educational programmes [3].

The use of assistive technology has been generally accepted in education to bridge the gap between special and regular schools which has resulted in the positive transformation of teaching and learning across the curriculum [12]. Al-Ani et al. (2020) explore students' with disabilities' use of Assistive Technology in learning and found that students perceive Assistive Technology positively, as it develops their abilities to search for information and provides them with more opportunities to share ideas and collaborate together [20]. Grönlund et al. (2010) found that obstacles to the effective use of Assistive Technology in developing countries come from three different levels which are the school, national, and network [2].

Learning takes many forms [16] however, there are many circumstances that will not result in achieving the desired effect of teaching [11]. In a nutshell, every student needs the opportunity to have learning experiences in line with the same learning goals. This will necessitate thinking about what supports individual students with special needs, meanwhile, overall strategies are to make sure that all students hear instructions that they do indeed need to start activities, all students participate in large group instruction, and that student's transition in and out of the classroom at the same time.

So, it is very essential for teachers to allow assistive technology to play its role in an inclusive educational system to enable the students with special needs to be more productive. Teachers also need to continue developing themselves technologically regardless of government support. Most teachers had either neutral or negative attitudes about inclusive education because they do not feel they are very knowledgeable, competent, or confident about how to educate students with special needs.

3. Methodology

3.1 Research Hypotheses

The following hypotheses were formulated and tested for the study.

1. Access to equal education can be achieved in an inclusive educational system if the inclusive educational system resists the role of assistive technology.
2. Inclusive education cannot fail, even if there is no periodical training programme for both the teachers and students in an inclusive educational system on the use of assistive technology tools.

3.2 Research Design

A descriptive research design was the choice of this study in eliciting responses from the respondents on the efficacy of assistive technology (AT) for improved teaching and learning of computer science in an inclusive education system in Nigeria. A descriptive research method was used for this study because it is a method of research that is based on information, interviews, inventories, rating scales etc., and aims at fact-finding of the present condition or current situation.

3.3 Population of the Study

The target population of this study comprises all the students with special needs conditions and all the teachers teaching this category of students in an inclusive education system, Oyo, Oyo State, Nigeria.

3.4 Sample and Sampling Technique

A purposive sampling technique was used to select the respondents from the population of the study. The population for the study comprised all special needs students and all teachers at Durbar Grammar School, Oyo. A random sampling technique was used to select twenty (20) teachers and all students with special needs were included (40).

3.5 Research Instrument

A self-developed structured questionnaire named Student-Teacher Assistive Technology Value Questionnaire (STATVQ) which has two sections A and B (section A to be answered by the teachers and section B to be answered by the students with special needs) was used to gather information from the respondents (teachers and students). Likert Scale ratings strongly agreed, agreed, disagreed, and strongly disagreed were used to indicate the extents to which the respondents agreed or disagreed with each of the statements. Likert Scale rating was used because it is widely used to measure attitudes and opinions with a greater degree of nuance than a simple "yes/no" question.

3.6 Validity of the Instrument

The instrument used was validated by an expert in the field of computer science, special education, measurement, and evaluation.

3.7 Reliability of the Instruments

A test-re-test method was used to ascertain its reliability and a reliability coefficient of 0.81 was obtained. The test-re-test method involved all students with special needs that are part of the population used for this study and ten (10) teachers who are not part of the population used for the study.

3.8 Procedure of Data Collection

The copies of the questionnaire were administered by the researcher personally and were collected back on the spot.

3.9 Method of Data Analysis

Frequency counts, simple percentages (%), and chi-square statistical methods of analysis were used to analyze the responses of the respondents in 4.0.

4. Results and Discussion

4.1. Hypothesis 1: Access to equal education can be achieved in an inclusive educational system if the inclusive educational system resists the role of assistive technology.

Table 1. Contingency Table showing the Observed, Percentage, and Expected (Teacher’s responses)

S/N	ITEMS	A			D		
		O	%	E	O	%	E
1.	Assistive technology can make the teaching of computer science more productive to students in an inclusive educational system.	20	100	16.5	-	0	3.5
2.	Assistive technology can make the teaching of computer science more individual to students in an inclusive educational system.	19	95	16.5	01	05	3.5
3.	Assistive technology can improve teachers teaching ability & students’ learning ability in an inclusive educational system.	16	80	16.5	04	20	3.5
4.	The teaching of computer science is more interesting when there is the availability of different technological tools to illustrate the teaching contents.	18	90	16.5	02	10	3.5
5.	Technology can make the learning of computer science more immediate.	16	80	16.5	04	20	3.5
6.	Technology can make access to education more equal.	16	80	16.5	04	20	3.5
7.	There is no provision for assistive technological tools in my school.	15	75	16.5	05	25	3.5
8.	There is no provision for special teachers in all subject offering by students’ with special need.	12	60	16.5	08	40	3.5
Total		132			28		

Key

Strongly Agree + Agree = Agree (A)
 Strongly Disagree + Disagree = Disagree (D)

Table 2. Presentation of Result for Hypothesis 1 (Teachers’ responses)

TOTAL AGREE	TOTAL DISAGREE	LEVEL	DF	χ^2 CAL	χ^2 TAB	DECISION
132	28	0.05	07	15.2381	14.067	Rejected

Key

DF = Degree of Freedom (1)

χ^2 CAL = Chi-Square Calculated (2)

χ^2 TAB = Chi-Square Table Value (3)

Table 1 shows the responses of twenty (20) teachers on hypothesis 1 that says “Access to equal education can be achieved in an inclusive educational system if the inclusive educational system resists the role of assistive technology”. It was discovered that 20 (100%) respondents agreed that, assistive technology (AT) can make the teaching of computer science more productive. 19 (95%) respondents also agreed that AT can make the teaching of computer science more individual to students in an inclusive educational system while only 1 respondent (5%) disagreed with the statement. 80% (16) respondents agreed that AT can improve teachers teaching ability and students’ learning ability while 20% (04) respondents disagreed with the statement. The result also revealed that 90% (18) respondents agreed that, the teaching of computer science is more interesting when there is an availability of different technological tools to illustrate the

teaching contents. 16 (80%) respondents also agreed that technology can make the learning of computer science more immediate and access to education more equal respectively. 75% (15) respondents agreed that there is no provision for assistive technological tools in the case study school while 5 (25%) respondents disagreed with the statement. 60% (12) respondents also agreed that there is no provision for special teachers in all subject offering by the students' with special needs and this statement was disagreed by 40% (8) respondents.

Using equations 1, 2 and 3, table 2 shows that the χ^2 calculated is **15.2381** with the degree of freedom (DF) **07** at a **0.05** level of significance, the χ^2 tab reading is given to be **14.067**. Since χ^2 CAL (**15.2381**) is greater than the χ^2 TAB (**14.067**), the hypothesis that says "Access to equal education can be achieved in an inclusive educational system if the inclusive educational system resists the role of assistive technology" is therefore rejected (for the teachers). The null hypothesis is restated as follows: "Access to equal education cannot be achieved in an inclusive educational system if the inclusive educational system resists the role of assistive technology". The result of this hypothesis supports the opinion of Guilford (2003) who opined that technology can make access to education more equal [9].

Table 3. Contingency Table showing the Observed, Percentage and Expected (Students responses)

S/N	ITEMS	A			D		
		O	%	E	O	%	E
1.	Assistive technology can make the learning of computer science more meaningful to students with special needs in an inclusive educational system.	40	100	33.5	-	0	6.5
2.	Assistive technology can make the learning of computer science more individual for students with special needs in an inclusive educational system.	38	95	33.5	02	05	6.5
3.	Assistive technology can improve the learning ability of students with special needs in an inclusive educational system.	36	90	33.5	04	10	6.5
4.	Learning is more interesting to students with special needs in an inclusive educational system when there is an availability of different technological tools to illustrate the teaching contents.	35	87.5	33.5	05	12.5	6.5
5.	Technology can make learning of computer science more immediate to students with special needs.	35	87.5	33.5	05	12.5	6.5
6.	Technology can make access to education more equal.	32	80	33.5	08	20	6.5
7.	There is no provision for an assistive technological tool for students with special needs.	36	90	33.5	04	10	6.5
8.	There are few provisions of assistive technological tools for students with special need.	16	40	33.5	24	60	6.5
Total		268			52		

Key

Strongly Agree + Agree = Agree (A)

Strongly Disagree + Disagree = Disagree (D)

Table 4. Presentation of Result for Hypothesis 1 (Students responses)

TOTAL AGREE	TOTAL DISAGREE	LEVEL	DF	χ^2 CAL	χ^2 TAB	DECISION
268	52	0.05	07	71.2744	14.067	Rejected

Table 3 shows the responses of forty (40) students to hypothesis 1 which says "Access to equal education can be achieved in an inclusive educational system if the inclusive educational system resists the role of assistive technology". It was discovered that 40 (100%) respondents agreed that, assistive technology (AT) can make the teaching of computer science more meaningful to students with special needs in an inclusive educational system. 38 (95%) respondents also agreed that AT can make the learning of computer science more individual to students in an inclusive educational system while only 2 respondents (5%) disagreed with the statement. It was also discovered that 90% (36) respondents agreed that AT can improve the learning ability of students with special needs as against 10% (4) respondents. The result also revealed that 87.5% (35) respondents agreed that, learning is more interesting when there is an availability of different technological tools to illustrate the teaching contents and 87.5% (35) respondents also agreed that technology can make the learning of computer science more immediate while 32 (80%) respondents agreed that technology can make access to education more equal. 90% (36) respondents agreed that there is no provision for assistive technological tools for students with special needs in the case study school as opposed to 4 (10%) respondents. 40% (16) of respondents agreed that there are little provisions for assistive technology tools for students with special needs while the majority of the respondents (60%) disagreed with the statement.

Using equations 1, 2 and 3, table 4 shows that the χ^2 calculated is **71.2744** with the degree of freedom (DF) **07** at a **0.05** level of significance, the χ^2 tab reading is given to be **14.067**. Since χ^2 CAL (**71.2744**) is greater than the χ^2 TAB (**14.067**), the hypothesis that says "Access to equal education can be achieved in an inclusive educational system if the inclusive educational system resists the role of assistive technology" is therefore rejected (for the Students). The null hypothesis is restated as follows: "Access to equal education cannot be achieved in an inclusive educational system if

the inclusive educational system resists the role of assistive technology”. The result of this hypothesis supports the opinion of Guilford (2003) who opined that technology can make access to education more equal [9].

4.2. Hypothesis 2: Inclusive education cannot fail, even if there is no periodical training programme for both the teachers and students in an inclusive educational system on the use of assistive technology tools.

Table 5. Contingency Table showing the Observed, Percentage, and Expected (Teachers responses)

S/N	ITEMS	A			D		
		O	%	E	O	%	E
1.	Even, if there is provision for technological tools, teachers in an inclusive educational system still need periodical training on the use of these technological tools.	16	80	13	04	20	07
2.	Teachers in an inclusive educational system do not have an interest in using assistive technology in their teaching because they lack the technical know-how.	10	50	13	10	50	07
Total		26			14		

Table 6. Presentation of Result for Hypothesis 2 (Teachers responses)

TOTAL AGREE	TOTAL DISAGREE	LEVEL	DF	χ^2 CAL	χ^2 TAB	DECISION
26	14	0.05	1	3.9560	3.841	Rejected

Table 5 shows the responses of twenty (20) teachers to hypothesis 2 which says “Inclusive education cannot fail, even if there is no periodical training programme for both the teachers and students in an inclusive educational system on the use of assistive technology tools”. It was discovered that 16 (80%) respondents agreed that, even, if there is a provision for technological tools, teachers in an inclusive educational system still need a periodical training programme on the use of these technological tools as opposed to the minority of the respondents (20%). The result also revealed that 50% (10) of the respondents agreed that teachers in an inclusive educational system do not have any interest in using assistive technology (AT) in their teaching because they lack technical know-how as against the same percentage (50%) of the respondents.

Reference to equations 1, 2, and 3, table 6 shows that, the χ^2 calculated is **3.9560** with the degree of freedom (DF) **01** at a **0.05** level of significance, the χ^2 tab reading is given to be **3.841**. Since χ^2 CAL (**3.9560**) is greater than the χ^2 TAB (**3.841**), the hypothesis that says “Inclusive education cannot fail, even if there is no periodical training programme for both the teachers and students in an inclusive educational system on the use of assistive technology tools” is therefore rejected (for the Teachers). The null hypothesis is restated as follows: “Inclusive education can fail if there is no periodical training programme for both the teachers and students in an inclusive educational system on the use of assistive technology tools”. The result of this hypothesis supports the opinion of Specht et al. (2007) who opined that, when recommending the use of assistive technology, one must consider how training can be provided for students, parents, and teachers to become competent with the technology, as well as environmental factors that will continue to support the child in using technology [13]. The result of this hypothesis also collaborates with the opinion of Okolo and Diedrich (2014) who opined that improved staff training and knowledge were the most important actions that could be taken to promote technology use [6].

Table 7. Contingency Table showing the Observed, Percentage, and Expected (Students responses)

S/N	ITEMS	A			D		
		O	%	E	O	%	E
1.	Students with special needs in an inclusive educational system need periodical training on the use of technological tools.	31	77.5	25.5	09	22.5	14.5
2.	Students with special needs in an inclusive educational system do not have an interest in using assistive technology in their learning process because they lack technical know-how.	20	50	25.5	20	50	14.5
Total		51			29		

Table 8. Presentation of Result for Hypothesis 2 (Students’ responses)

TOTAL AGREE	TOTAL DISAGREE	LEVEL	DF	χ^2 CAL	χ^2 TAB	DECISION
51	29	0.05	1	6.5450	3.841	Rejected

Table 7 shows the responses of forty (40) students to hypothesis 2 which says “Inclusive education cannot fail, even if there is no periodical training programme for both the teachers and students in an inclusive educational system on the use of assistive technology tools”. It was discovered that 31 (77.5%) respondents agreed that, students with special needs in an inclusive educational system need periodical training on the use of technological tools as opposed to a minority of the respondents (i.e 22.5%). It was also discovered that 50% (20) of the respondents agreed that students with special needs in an inclusive educational system do not have an interest in using assistive technology (AT) in their learning process because they lack technical know-how as against by same percentage (i.e 50%) of the respondents.

Reference to equations 1, 2, and 3, table 8 shows that the χ^2 calculated is **6.5450** with the degree of freedom (DF) **01** at a **0.05** level of significance, the χ^2 tab reading is given to be **3.841**. Since χ^2 CAL (**6.5450**) is greater than the χ^2 TAB (**3.841**), the hypothesis that says “Inclusive education cannot fail, even if there is no periodical training programme for both the teachers and students in an inclusive educational system on the use of assistive technology tools” is therefore rejected (for the Students). The null hypothesis is restated as follows: “Inclusive education can fail if there is no periodical training programme for both the teachers and students in an inclusive educational system on the use of assistive technology tools”. The result of this hypothesis supports the opinion of Michaels and McDermott (2003) who agreed that students’ successful implementation of assistive technology is directly related to the knowledge, skills, and dispositions of special education teachers [5].

5. Conclusion

This study has examined the efficacy of assistive technology for improved teaching and learning in computer science among learners with special needs. The result of Table 2 and Table 4 of this study shows that both the teacher and the students disagree with research hypothesis one (1) which says “Access to equal education can be achieved in an inclusive educational system if the inclusive educational system resists the role of assistive technology” and this reflected in the result with a significant of 1.1711 and 57.2074 respectively both tested at the same significant level of 0.05 with the degree of freedom (DF) 07. The null hypothesis is therefore restated as “Access to equal education cannot be achieved in an inclusive educational system if the inclusive educational system resists the role of assistive technology” It is therefore recommended that all the stakeholders in an inclusive educational system should allow the assistive technology to play its role.

Similarly, the result of Table 6 and Table 8 shows that both the teachers and the students disagree with research hypothesis two (2) which says “Inclusive education cannot fail, even if there is no periodical training programme for both the teachers and students in an inclusive educational system on the use of assistive technology tools” and this reflected in the result with a significant of 0.115 and 2.704 respectively both tested at the same significant level of 0.05 with the degree of freedom (DF) 01. The null hypothesis is restated as follows: “Inclusive education can fail if there is no periodical training programme for both the teachers and students in an inclusive educational system on the use of assistive technology tools”. It is therefore recommended that a periodical training programme on the use of assistive technology be organized by the school administrators, the government, educational stakeholders as well as non-governmental agencies for both the students with special needs and all the teachers teaching in an inclusive educational system so as to enable the special needs students to perform excellently in their academic and also to enable the teachers teaching in an inclusive school enjoy their teaching.

6. Recommendations

Based on the findings of this study, the following recommendations were provided:

1. Teachers in an inclusive educational system must embrace the use of assistive technology in teaching computer science to their students.
2. Periodical training programmes on the use of assistive technology must be organized by the school administrators, the government, educational stakeholders as well as non-governmental agencies for students with special needs and their teachers in an inclusive educational system so as to improve the efficiency of the system.
3. Nigeria teachers’ education programme must integrate a course that will expose the potential teachers to inclusion education motive principle.
4. Government should employ both teachers with special education and those without special education into an inclusive educational system so as to cover up any lapses.
5. Government should provide adequate assistive technological tools needed for the teaching of computer science in an inclusive educational system.

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