

## **Impact of Electronic Braille Note-Taking Devices Use on Academic Performance of Visually Impaired Learners in Selected Special Primary Schools in Kenya**



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**ABSTRACT:** Owing to technological advancements, Electronic Braille note-taking (EBN) devices have been developed and are currently in use by learners with visual impairment in Kenya. This study intends to examine the impact of EBN devices on academic performance of visually impaired learners in selected special primary schools in Kenya. The study used a descriptive design while applying both quantitative and qualitative approaches. Six special schools were purposively sampled: St. Francis Special School in West Pokot County, Marigat Special School in Baringo County, Kiomiti Special School in Kisii County, Korara Special School in Bomet County, Kibos Salvation Army School for Visually Impaired in Kisumu County and Salvation Army Thika Special Primary School in Kiambu County. The data was analyzed both descriptively and thematically. The results were presented in form of tables and figures. The findings of the study show that the EBN devices as used in the primary schools for visually Impaired learners in Kenya have a positive impact on their academic performance. This study recommends that the stakeholders of schools with Visually Impaired learners to increase the supply and distribution of EBN devices to the schools so as to achieve the recommended 1:1 device to learner ratio.

**KEYWORDS:** Impact, Electronic Braille note-taking devices (EBN), Learners with Visual Impairment (LVIs), Braille, Special Schools, Assistive Technology (AT)

### **I. INTRODUCTION**

People living with different types of disabilities often require assistive technology to improve their body function and performance and to be economically productive in future. Assistive technology (AT) includes any type of device or system whose primary purpose is to maintain or improve an individual's functioning and independence to facilitate participation and enhance quality of life. These devices can also help prevent secondary health conditions and further impairment. A large variety of ATs are available ranging from low to high-tech products that provide the opportunity for persons with disabilities to enhance their well-being and quality of life. People who need assistive technologies move through various institutional processes to access these tools and resources. However, there are documented inequities in both access to services and funding mechanisms in the acquisition processes. This has made it difficult to acquire assistive products for more than one billion people requiring the assistive technology [1].

There are three primary issues facing individuals with visual impairments: access to information, independent travel and a scarcity of meaningful experiences. Assistive technology is employed by individuals with visual impairments to catch up on these limitations. Assistive technology can enable learners who are visually impaired to realize educational success and gain competitive employment by providing tools for increased independent access to information and for effective communication. The present challenge is to supply appropriate instruction in the use of assistive technology as tools and equitable distribution of assistive technology [15].

Braille as a tactile orthography employed by people who are visually impaired is traditionally written with embossed paper. This has always been done using mechanical Braille machines on a special Braille paper: an activity that is quite costly and requires a lot of physical effort. Recent advancements in technology have resulted in the development of Electronic Braille note-taking devices with refreshable Braille displays. Charitable organizations have stepped in and provided the EBN devices in a bid to assist LVIs achieve their educational goals in Kenya. The devices have also been availed through personal acquisition and school procurement. An example of EBN devices is the Orbit reader which was identified by The Kilimanjaro trust Africa as the electronic Braille note-taking/reading device of choice in Kenya. It was developed as a reasonable electronic Braille device to be used in Africa and other developing countries. The Kilimanjaro trust Africa team identified several advantages to using this device such as its ability to eliminate the cost of manufacturing Braille material on paper [16].

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The performance of learners with visual impairment (LVIs) in Kenyan special primary schools has been evidently dismal. The performance of LVIs has long been below the national mean in KCPE examination. The teaching of Braille in Kenyan schools for learners with visual impairments is also wanting [20]. This can be attributed to the inappropriateness of the writing equipment such as the braille and slates and styluses which are not the best; nevertheless, they are the most widely used. Braille is expensive and requires expensive braille papers and maintenance while using slates and styluses is confusing since writing is done in reverse [21]. EBN technology was a recent introduction for use by the visually impaired especially in Africa and other developing countries. There is therefore barely any research data on its application as alternative assistive technology. The extent to which the EBNs influence the academic performance of visually impaired learners in Kenya has not been established. There was therefore a need to determine the impact they have on performance.

This study attempts to create understanding on the impact of EBN devices on academic performance. To determine the impact of these devices, this paper examines an additional factor that determines the use of these devices: the adequacy of the EBNs.

### **II. LITERATURE REVIEW**

Assistive technology is employed by learners who are visually impaired not only to interact in literacy tasks (such as creating documents) but also to gain access to a curriculum. Despite all of its acknowledged importance, there's little research on the ways in which technology has changed the reading and writing practices to learners who use braille [9].

At present, dim-sighted people who are trained users of Braille systems can interpret information from computers and other electronic gadgets with the usage of braille note-taker, braille writer and special braille displays. Braille note-taker popularly referred to as Braille PDA, really comes in handy. These electronic memo machines are small, portable devices for storing information with the utilization of Braille or QWERTY keyboards. With the assistance of note-taker, one can browse quietly using the Braille display [13].

Braille note takers are electronic braille writers with a similarity to the Perkins braille with QWERTY or Perkins style braille keys for entering information. These handy devices use a braille refreshable display speech synthesizer or audio output of what has been typed as feedback of the output. The knowledge is then stored within the note-taker for later reference. If the users want to store large amounts of knowledge, it is often transferred to a computer via a USB cable or Bluetooth since the devices might not have large storages. The output also can be printed on a Braille printer. Since they're light and mobile, they're suitable for learners who require notes during a classroom. They also provide basic organizational tools, like a calendar and that they also can be used to send or receive email [3].

EBNs have built-in refreshable braille displays that connect to the Internet and have word processors and other software applications that allow users to perform school, an office, or personal tasks away from home (NLS, 2021). EBN device is a multipurpose device which not only takes notes but also; serves as a reading and writing media, gives access to the internet, records short telephone numbers and messages for later retrieval, executes ordinary and scientific calculations, keeps track of time and appointments and, facilitates the composition and printing of essays [6].

A study was carried out on the Preferences and Practices among Learners aged between 13 to 22 who read Braille and use Assistive Technology in the United States. The researcher found out that besides using braille and technology for editing papers and reading textbooks, learners mentioned a number of other school tasks and complex practices utilizing Assistive technology. The tasks included getting online to do research, and writing essays and creating projects for class assignments. The study also asked the learners to describe their experiences with multi-literacy activities, such as creating presentations, using Google Docs, participation in interactive writing tasks, creating and, using the Internet and using blogs for classroom tasks. Several learners mentioned communicating through email with instructors and submitting homework and class assignments via email, so this was also explored in the interviews and then later in the survey [11].

D'Andrea (2010) also reported benefits for learners who use both hard copy and electronic braille depending on the context. The study was on Acquisition of Literacy Skills by Young Children Who Are Blind. The researcher suggested that early introduction of braille technology for use across the curriculum is both appropriate and increasingly necessary. Respondents in this study generally agreed that technology is a motivator for learners and that the use of technology in braille instruction could generate more positive learning outcomes [10].

Bickford and Falco (2012), attempted to quantify the efficacy of utilizing the electronic braille note-taker in braille literacy instruction, based on the Patterns curriculum. They found out that the use of electronic devices and note-takers led to greater gains in fluency and proficiency and provided added motivation for learners during instructional phases using the electronic note-taker than during instructional phases utilizing traditional techniques [4]. Cooper and Nichols (2007) also realized the same advantages in a study where electronic braille writers were provided to 20 learners. They found that participants with delayed motor skills and limited finger strength were ready to produce braille with less fatigue for extended period of time. The electronic braille writers were less disruptive than the traditional mechanical braille writers. The audio feedback motivated the learners more hence

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assisting them in staying on task and learning braille letters at a faster rate than many teachers felt they could with conventional technologies alone [7].

While studying the Impact of Assistive Technology on Curriculum Accommodation for a Braille-Reading Student, Farnsworth JR & Luckner (2008) discovered that the braille note-takers were fostering a learner's independence, enabled them to conduct their class work at a faster and more efficient pace. They even gave an analogy of how it was like going from 'a horse and buggy' to a car. The learners were able to do more of their homework with less fatigue compared to when they used the traditional means. The devices enabled teachers and paraprofessionals who had no experience with the literary Braille code to generate and emboss Braille documents with a minimum of training. Having teachers and paraprofessionals do this work allowed vision specialist teachers to concentrate on teaching their learners rather than on translating literary Braille into print [12].

A study reported on the use of Braille note-takers with refreshable Braille displays to assist Braille-reading learners in British Columbia, Canada. In the study, the rationale for using these devices in classrooms was supported by the Braille-Note's ability to access Windows applications like Microsoft Word. Teachers could easily, quickly, and, with a high degree of accuracy, translate electronic files from Braille to print and vice versa. In addition, learners using Braille note-taker were able to read documents in un-contracted or contracted Braille formats, send and receive e-mail, store class notes, and perform scientific calculations. Findings on the impact of assistive technology on educational achievement of learners with visual impairment revealed that majority of the teacher noted that Jaws, non-visual desk top access, note takers, tablets, enlarged screen, smart braille, audio books, smart phones and computers that are the necessary assistive technologies that should be availed to learning centres if the visually impaired are going to achieve educationally at the same level as other learners without impairment. According to the learners and teachers involved in the study, the technology provides a better alternative way of learners accessing information and knowledge independently, easily, quickly and frequently without bothering any other person as it has been the case in the past. It further emerged that the use of assistive technology has enormous contribution toward curriculum coverage and early completion, hence, positively influencing educational achievement on secondary school learners. The study also supports the view that there is high interaction between the learning material, learners themselves and the teacher through assistive technology [15].

In Rwanda, a researcher conducted a study to assess the impact of assistive technology on education performance of learners with visual impairment at the University of Rwanda. It was found out that visually impaired learners use assistive technology such as use braille machines, abacus, EBNs, embossers, thermos-formers, slate and stylus. The study emphasized that technology addresses special needs issues as information storage and retrieval. Students with visual impairment compete comparatively in the end with those without special needs in the education and job market [5].

A study conducted in Kenya to assess the use of modern assistive technology and its effects on educational achievement of students with visual impairment was carried out at Kibos Special School in Kenya. In the study, teachers supported assistive technologies use and that they should be availed to learning centres if the visually impaired are going to perform well educationally at the same level as other learners without impairment. According to the students and teachers involved in the study, the technology provides a better alternative way of students accessing information and knowledge independently, easily, quickly and frequently without bothering any other person as it has been the case in the past. It further emerged that the use of assistive technology has huge contribution toward curriculum coverage and early completion, hence, positively influencing educational achievement on LVIs [23].

The previous studies shed light on some of the features of the EBN devices available and their uses. The impact of ATs in general on the academic performance of LVIs has also been covered. The direct relationship between EBN devices specifically and the academic performance of LVIs has not been established in Kenya. This study was undertaken to take a critical look at the use of EBN to find out their impact on academic performance.

### III. METHODOLOGY

#### A. *Research Design and Approach*

To meet the goals of the study, a descriptive survey design was used. The design involved acquisition of information about one or more phenomenon through the use of questionnaires, interview and observation schedules. Besides, it allowed for the generation of an accurate description of the use of EBNS; establish opinions, competencies, attitudes, and suggestions for improvement. Descriptive research was an appropriate choice since this study used data collected to describe the variables that influence the use of EBN and the impact these devices had on the academic performance of LVIs as used over time. This design also allowed for the mixed methods approach since both quantitative and qualitative data was collected.

#### B. *Study Area and Target Population*

The study was carried out in the following six counties in Kenya: Bomet County, West Pokot County, Baringo County, Kisumu County, Kiambu County, and Kisii County. The six counties offered a suitable study area since they had well-established special

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schools for VI. The study focused on the six Special Schools in these counties since they had a rich variety of assistive technology including EBN devices being utilized by learners with Visual Impairment.

The population under study was drawn from all special primary schools that provide educational services to learners with VI in Kenya. The study population therefore included 15 special schools for learners with Visual Impairment. The 15 special schools were widely dispersed throughout the various counties in Kenya. This included a population of 793 learners and 96 teachers. The accessible population was however drawn from a section of upper classes which consisted of grade 5 and STD 7 classes reducing the sample to 210 learners. The learners that form these classes were the potential candidates in their respective curriculums and due to their seniority after the candidate class, they had the ability to comprehend the study instruments.

### C. Sampling Technique and Sample Size

Purposive sampling technique was used to select special schools that had been long established. Well-established schools were selected because they were likely to be the most endowed with assistive technology including EBN devices. An appropriate sample size for a descriptive survey should be atleast 30% of the population for a population less than 1000 [17]. The study sampled 6 out of the 15 special schools in Kenya: 40% of the target schools. The study further sampled Standard 7 and Grade 5 learners. Both classes were capable of comprehending the research instruments. A sample of 210 Grade 5 and STD 7 pupils from the 6 sampled schools and all their 96 teachers were to participate in the study as presented in the Table 2 below.

**Table I: Sample Size Distribution**

SR. NO	School	County	Number of learners in Grade 5	Number of learners in STD 7	Total (5 & 7)	Teachers	Head teachers
1	St. Francis Special School	West Pokot	11	14	25	13	1
2	Korara Special Primary School (VI)	Bomet	15	18	33	8	1
3	Kibos (SA) Primary School for VI	Kisumu	14	10	24	13	1
4	Kiomiti Special School for VI	Kisii	9	8	17	8	1
5	Marigat Special School for VI	Baringo	12	20	32	12	1
6	Thika SA Special Primary School for the Blind	Kiambu	42	37	79	42	1
	<b>Total</b>		<b>103</b>	<b>107</b>	<b>210</b>	<b>96</b>	<b>6</b>

### D. Sampling Technique and Sample Size

The researcher employed the use of questionnaires and observation schedules as the tools of the study so as to obtain the most accurate primary data. Questionnaires were suitable for this study since they had standardized answers that made it simple to compile data and their administration was cheap and did not require as much effort from the questioner as verbal or telephone surveys [14]. The researcher administered three sets of questionnaires tailored to three sets of respondents: Learners with Visual Impairments, their teachers and their head teachers. Observation schedules were also appropriate since using them enabled the researcher to obtain primary data on the utilization of EBN devices and their efficiency. It also enabled the researcher to confirm the authenticity of questionnaire responses.

### E. Data Analysis

Before processing the responses, data preparations were done on the completed questionnaires by editing, coding, entering and cleaning the data. Data analysis involved both descriptive and inferential statistics. The descriptive statistics of means, percentages and frequency was computed in order to describe the data in terms of the quantities. Qualitative data were analyzed thematically. The results were presented in form of figures, tables, and charts for ease of understanding. After the analysis had been done, conclusions and recommendations were made on the impact of EBN devices on academic performance of LVIs.

## IV. RESULTS AND DISCUSSIONS

### A. Response Rate

So as to find out the impact of EBN devices, questionnaires were distributed learners, teachers and their head teachers in the six sampled schools. The researcher administered 210 questionnaires and got responses from 195 (92.86%) of the learners. Out of the 96 questionnaires distributed to the teachers, the researcher received back 91(94.79%). The researcher also distributed 6 questionnaires to the head teachers of the schools and received back 5(80%). The responses are presented in Table 2.

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**Table II: Response Rate**

Category	Questionnaires administered	Questionnaires Returned	
		Frequency	Percentage
Teachers	96	91	94.79%
Learners	210	195	92.86%
Headteachers	6	5	80%

The response was noted as adequate enough to be used for the analysis. A response rate of 70% and above is adequate for a study [19].

### B. Adequacy of EBN Devices

The number of the EBN devices in the schools versus enrolment of learners in each school was established so as to determine the adequacy of the devices. The findings were presented in the table 5 below. The schools were coded using numbers to maintain confidentiality in adherence to the ethical considerations of research.

**Table III: Adequacy of EBN Devices.**

School	Enrolment	Number of EBNs	Ratio
1	125	16	1:8
2	120	40	1:3
3	57	20	1:3
4	85	8	1:10
5	185	29	1:6
6	221	45	1:5
<b>Total</b>	793	158	1:5

From table 4, there was a total of 158 EBN devices distributed among 793 learners. The devices were distributed at a mean ration of 5 learners to 1 EBN. This meant that the EBN devices were not adequate. This data was also backed up by the views of the headteachers on the quantity of the EBNs where 5(100%) of the respondents stated that the EBN were not adequate. The researcher also observed that the devices were distributed to the learners in the senior most classes and the teachers prioritised the learners who were totally blind in the distribution in four schools. Two of the schools distributed them according to the number of learners in a class. This meant that the learners would have to share the device which was not ideal for their utilization. Learners have better learning experiences and performance with a 1:1 device-student ratio [18] which has not been achieved in this case.

The findings in this study concurs with the findings of Alabi, Dominic and Ibrahim (2018), whose findings revealed that assistive technologies were not adequately available in special education schools. The few available assistive devices that were available were not adequate. They also found out that the special education teachers did not use the available assistive devices to teach students with disabilities [2]. Another study in Kenya supports these findings since it revealed that Electronic AAT devices of Optacon, note taker, OCR scanner and refreshable Braille display machine were not adequate in the schools under their study [11].

### C. Respondents Views on the Impact of EBNs in the Academic Performance

A list consisting of three (5) statements was presented to the one hundred and ninety-five (195) learners, ninety-one (91) teachers, five (5) headteachers as the three sets of the study respondents. The data was collected using five-point Likert scale questionnaire format of which the positively stated statements were scored positively as follows; strongly agree (SA)=5, agree (A)=4, Not Sure (NS)=3, disagree (D)=2, and strongly disagree (SD)=1. The score was reversed for the negatively stated statements. The results for the set of opinion statement were presented, analyzed and discussed in three sets.

**Table IV: Respondents' responses on the Impact of EBNs on the Academic Performance of LVIs**

Statement (Learners' responses)	SD (1)	D (2)	NS (3)	A (4)	SA (5)	Mean
Adequacy of EBNs affects my academic performance	2 (1.03%)	10 (5.13%)	13 (6.67%)	85 (43.59%)	85 (43.59%)	4.67



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Teacher preparedness on the use of EBN has an impact on my academic performance	13 (6.67%)	11 (5.64%)	12 (6.15%)	86 (44.10%)	73 (37.43%)	4.44
EBN improves the learner's ability to read and write in Braille	6 (3.08%)	17 (8.78%)	14 (7.18%)	87 (44.62%)	71 (36.41%)	4.47
The EBN is ineffective in learning	101 (51.79%)	58 (29.74%)	11 (5.64%)	11 (5.13%)	15 (7.69%)	4.42
The EBN has had a positive impact on learners' academic performance	1 (0.51%)	8 (4.10%)	26 (13.33%)	102 (52.31%)	58 (29.74%)	4.59
<b>Teachers' responses</b>	<b>SD (1)</b>	<b>D (2)</b>	<b>NS (3)</b>	<b>A (4)</b>	<b>SA (5)</b>	
Adequacy of EBNs affects my academic performance	9 (9.89%)	15 (16.48%)	11 (12.09%)	30 (32.97%)	26 (28.57%)	3.54
Teacher preparedness on the use of EBN has an impact on my academic performance	1 (1.099%)	4 (4.40%)	5 (5.49%)	34 (37.36%)	47 (51.65%)	4.34
EBN improves the learner's ability to read and write in Braille	0 (0%)	0 (0%)	6 (6.59%)	59 (64.84%)	26 (28.57%)	4.22
The EBN is ineffective in learning	32 (35.16%)	50 (54.95%)	8 (8.79%)	1 (1.10%)	0 (0%)	4.24
The EBN has had a positive impact on learners' academic performance	2 (2.20%)	3 (3.30%)	6 (6.59%)	49 (53.85%)	31 (34.07%)	4.14
<b>Head Teachers' Responses</b>	<b>SD (1)</b>	<b>D (2)</b>	<b>NS (3)</b>	<b>A (4)</b>	<b>SA (5)</b>	
Adequacy of EBNs affects my academic performance	0(0%)	1 (20%)	1 (20%)	3 (60%)	0 (0%)	3.4
Teacher preparedness on the use of EBN has an impact on my academic performance	0(0%)	0(0%)	0(0%)	2 (40%)	3 (60%)	4.6
EBN improves the learner's ability to read and write in Braille	0 (0%)	0(0%)	1 (20%)	2 (40%)	2 (40%)	4.2
The EBN is ineffective in learning	2 (40%)	2 (40%)	1 (20%)	0 (0%)	0(0%)	4.2
The EBN has had a positive impact on learners' academic performance	0(0%)	1 (20%)	0(0%)	3 (60%)	1 (20%)	3.8
<b>Overall mean</b>						4.22

Table IV shows that 85 (43.59%) respondent learners strongly agreed with the statements that adequacy of EBNs affects performance with another 85 (43.59%) agreeing with this statement. 13 (6.67%) of the learners were not sure while 10 (5.13%) disagreed and 2 (1.03%) strongly disagreed. The learners agreed that adequacy of the devices affects performance at a mean of 4.67. On if teacher preparedness affected the performance of LVIs, most of the learners agreed with this statement at a frequency of 86 (44.10%). 73 (37.43%) of the learners strongly agreed with this statement while 13 (6.67%) Strongly disagreed, 12 (6.15%) were not sure and 11 (5.64%) disagreed. The learners agreed with this statement at a mean of 4.44. The study also sought to establish whether the EBNs have improved the learners' braille reading and writing skills. 87 (44.62%) learners agreed, 71 (36.41%) strongly agreed with the statement, 17 (8.78%) disagreed, 14 (7.18%) were not sure and 6 (3.08%) strongly disagreed. The learners agreed with this statement at a mean of 4.47. On the statement 'The EBN is ineffective in learning', most of the learners strongly disagreed with this statement at a frequency of 101 (51.79%). 58 (29.74%) of the learners disagreed, 11 (5.64%) were not sure, 11 (5.64%) agreed with the statement while 15 (7.69%) Strongly agreed. The learners disagreed that EBNs are ineffective at a mean of 4.58. When asked if the EBN has had a positive impact on their academic performance, 102 (52.31%) of the learners agreed while 58 (29.74%) strongly agreed, 26 (13.33%) were not sure, 8 (4.10%) disagreed and 1 (0.51%) strongly disagreed. The learners agreed with this statement at a mean of 4.59. The opinion of the learners on the impact of EBN in their academic performance was recorded at a mean of 4.52. This indicated that the learners were of the opinion that EBN has had a positive impact their academic performance.

The findings in Table IV revealed that 30 (32.97%) respondent teachers strongly agreed with the statements that adequacy of EBNs affects performance with another 26 (28.57%) agreeing with this statement. 15 (16.48%) of the respondent teachers disagreed while 11 (12.09%) were not sure and 9 (9.89%) strongly disagreed. The teachers had a mixed reaction towards adequacy of the devices affecting performance at a mean of 3.54. On whether teacher preparedness affected the performance of LVIs, most of the teachers strongly agreed with this statement at a frequency of 47 (51.65%). 34 (37.36%) of the teachers agreed with this statement while 5 (5.49%) were not sure, 4 (4.40%) disagreed and 1 (1.099%) strongly disagreed. The teachers agreed with this statement at a mean of 4.34. The study also sought to establish whether the EBNs have improved the learners' braille

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reading and writing skills. 59 (64.84%) teachers agreed, 26 (28.57%) agreed with the statement while 6 (6.59%) were not sure. The teachers agreed with this statement at a mean of 4.22. On the statement 'The EBN is ineffective in instruction', most of the teachers disagreed with this statement at a frequency of 50 (54.95%). 32 (35.16%) of the teachers disagreed, 8 (8.79%) were not sure while 1 (1.10%) agreed with the statement. The teachers disagreed that EBNs are ineffective at a mean of 4.24. When asked if the EBN has had a positive impact on their learners' academic performance, 49 (53.85%) of the teachers agreed and 31 (34.07%) strongly agreed. 3 (3.30%), were not sure, 3 (3.30%) disagreed and 2 (2.20%) strongly disagreed. The teachers agreed that the EBN has had a positive impact on their learners' academics at a mean of 4.14. The opinion of the teachers on the impact of EBN in academic performance was recorded at a mean of 4.14. This indicated that the teachers were of the opinion that EBN had a positive impact the academic performance of LVIs.

The findings also revealed that a majority, 3(60%) respondent head teachers agreed with the statement that adequacy of EBNs affects performance while 1(20%) was not sure and another 1(20%) disagreed. The head teachers had a mixed reaction towards adequacy of the devices affecting performance at a mean of 3.4. On whether teacher preparedness affected the performance of LVIs, most of the head teachers strongly agreed with this statement at a frequency of 3(60%) while the other 2(40%) head teachers agreed with this statement. The head teachers agreed with this statement at a mean of 4.6. The study also sought to establish whether the EBNs have improved the learners' braille reading and writing skills. 2(40%) head teachers agreed, 2(40%) agreed with the statement while 1(20%) were not sure. The head teachers agreed with this statement at a mean of 4.2. On the statement 'The EBN is ineffective in instruction', the head teachers strongly disagreed with this statement at a frequency of 2(40%) while 2(40%) disagreed and 1 (1.10%) were not. The head teachers disagreed that EBNs are ineffective at a mean of 4.2. When asked if the EBN has had a positive impact on their learners' academic performance, 3 (60%) of the head teachers agreed while 1 (20%) strongly agreed and 1 (20%) disagreed. The head teachers agreed that the EBN has had a positive impact on their learners' academics at a mean of 3.8. The overall opinion of the head teachers on the impact of EBN in academic performance was recorded at a mean of 4.04. This indicated that the learners were of the opinion that EBN has had a positive impact the academic performance of LVIs.

All the respondents closely agree that EBNs had positive impact on the performance of learners. The overall opinion of the respondents on the impact of EBN was recorded at a mean of 4.22. This indicated that the respondents believed that the EBN had positive impact on the academic performance of learners. These findings concur with Bickford and Falco (2012), who attempted to quantify the efficacy of utilizing the electronic braille note-taker in braille literacy instruction, based on the Patterns curriculum. They found out that the use of electronic devices and note-takers led to greater gains in fluency and proficiency and provided added motivation for learners during instructional phases using the electronic note-taker than during instructional phases utilizing traditional techniques [4, 7].

Inadequate as they were, the EBN devices managed to impact the academic performance of LVIs positively. There is therefore a need to ensure the devices are available and are utilized to achieve desired academic performance.

### ***D. Limitations in the utilization of sEBNs***

To further investigate the impact of EBN, the study investigated the limitations that EBN had using an open-ended question. The respondents were asked to state the challenges that they faced as they utilized EBN technology in teaching and learning. The findings were as discussed as follows:

- i *Shortage of the devices:* The respondents mentioned the inadequacy of the EBNs as one of the main challenges impeding their use in achieving desired academic performance. The respondents claimed that the devices were not enough such that they had to share which was not ideal since the devices were designed to be used by one user at a go.
- ii *Breakdowns:* The devices are delicate and require handling with care. Some respondent head teachers stated that some of their learners were careless and ended up damaging the devices. Some respondent learners complained of unresponsive Braille keys(dots) which prevented them from writing the correct Braille characters they needed to write. Other respondent learners complained of defects in the refreshable Braille display. Some of the dots on the refreshable Braille display could cease popping up as expected. They also mentioned that some of the EBNs could hang some times while in use. The EBNs could easily breakdown when in contact with liquids. The charging ports of the devices could also easily break down if not handled with care. In case of breakdowns, there were no experts nearby to help with the repairs and maintenance.
- iii *Storage:* Some of the EBN devices did not have internal storage and depended solely on external storages such as SD cards. The SD cards were externally placed and could easily be lost since the LVIs were curious and ended up losing the storage cards as they explored the features of the EBNs.

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- iv *Electric power*: Since the EBNs depended on electricity, some schools complained of unsteady power supply which impeded the use of these devices. Some of the schools did not have enough charging stations hence the learners had to wait in turns to charge their devices.
- v *Swahili Braille contraction*: Stated by a respondent and confirmed by the researcher through observation, the EBN software was designed to contract Braille in English and other major language groups but not in Swahili. Any text files in Swahili could not be contracted according to Swahili contraction which could confused the learners. Swahili literature had to be converted into contracted Braille files using Braille converting software before transferring them into the EBN. There are very few applications software that could convert Braille files according to Swahili contraction. The researcher could only identify one which also required expensive licenses.
- vi *Training*: To be able to utilize the EBNs effectively, the respondents required proper training. The kind of training required took a lot of time which turned out to be challenging since the tight schedules in the schools did not allow extra time for such trainings. The training also involved a lot of rote learning for the EBN commands and lots of practise on top of the class work that the respondents already had. Some respondent head teachers cited the need for retraining of the teachers on the use of the EBNs.

The challenges as discussed affected the use of EBNs in achieving the desired academic performance. Even though the EBNs have had a notable slight positive impact on the performance of the learners, each of the challenges or a combination of some if not all have impeded the realization of the full potential of the EBNs. D'Andrea (2019) sounded out that some of the participants in their study mentioned that a disadvantage of the assistive technology is that it can just cease working properly or crash, often at the most inopportune times. The challenges that were met during the use of the technology could even cultivate negative attitudes in learners and result in disuse [11].

### V. CONCLUSIONS

The study concluded that the EBN devices in the schools for visually Impaired learners in Kenya were inadequate at the time of this study. Despite the inadequacy, the EBN devices had a positive impact on the academic performance of the learners. This study reaffirmed the importance of using technology in the instruction of learners especially those with special needs. The positive impact that has been noted in the use of EBN devices could be just the tip of the iceberg if only the devices were adequate.

### RECOMMENDATIONS

- i. The Kenyan government and special school stakeholders should increase the supply and distribution of EBN devices to the schools for the visually impaired so as to meet the 1:1 policy recommended device to user ratio.
- ii. The stakeholders such as the learners, teachers and the parents of the LVIs should take advantage of the available EBN devices despite their inadequacy and make full use of them in an effort to achieve the best results possible.
- iii. Tertiary institutions that provide trainings to teachers for the visually impaired and Braille technicians should incorporate EBN use in their curriculum so as to increase the level of teacher preparedness in the use of these devices for instruction.
- iv. The manufacturers of the EBNs and Braille translating software should consider adding Swahili contractions to their applications.

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### REFERENCES

- 1) Addis, B. M., Britton, J., & Davies, C. (2016). Challenges and Barriers to the Use and Provision of Assistive Technology in Africa: A Systematic Review . *Queen's University*.
- 2) Alabi, T. O., Dominic, S., & Ibrahim, I. K. (2018). Availability Adequacy and Utilization of High-Tech Assistive Technology in Special Education Schools in North West Nigeria. *Educational Techonolgy* (pp. 589-594). 6th International Conference of School of Science and Technology Education (SSTE).
- 3) Aranyanak, I. (2014). An experimental analysis of braille reading using a high-resolution tracking system. *National University of Ireland Maynooth*, 24-100.
- 4) Bickford, J. O., & Falco, R. A. (2012). Technology for early braille literacy: Comparison of traditional braille instruction and instruction with an electronic notetaker. *Journal of Visual Impairment & Blindness*, 106(10), 679-693.



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- 5) Bolingo, A. (2019). Impact Of Assistive Technology On Education Performance Of Learners With Visual Impairment At The University Of Rwanda - College Of Education. *University Of Rwanda*, 36.
- 6) Chong , M. (2000). The current state of technology for the blind and the challenge for the twenty-first century. *The Braille Monitor*, 53-68.
- 7) Cooper, H. L., & Nichols, S. K. (2007). Technology and early braille literacy: Using the Mountbatten Pro Brailler in primary-grade classrooms. *Journal of Visual Impairment & Blindness*, 101(1), 22-31.
- 8) Cooper, H. L., & Nichols, S. K. (2007). Technology and Early Braille Literacy: Using the Mountbatten Pro Brailler in Primary-grade Classrooms. *JVIB*, 13-17.
- 9) D'Andrea, F. M. (2010). *Practices and preferences among students who read Braille and use assistive technology*. University of Pittsburgh.
- 10) D'Andrea, F. M. (2019). Preferences and Practices among Students who Read Braille and use Assistive Technology. *Journal of Visual Impairment & Blindness*.
- 11) Ejoru, W. E. (2019). *Stakeholders Level of Preparedness On Use of Alternative Assistive Technology Among Learners with Visual Impairment in Turkana County*. Turkana: Maseno University.
- 12) Farnsworth JR, C. R., & Luckner, J. L. (2008). The Impact of Assistive Technology on Curriculum Accommodation for a Braille-Reading Student. *Heldref Publications*, 178-186.
- 13) Hynes, R. J., Jebaraj, J. J., Kumar, S. J., Immanuel, S., & Sankaranarayanan, R. (2019). Portable electronic braille devices – An overview. *AIP Conference Proceedings 2142, 140018*. AIP Publishing.
- 14) Kabir, S. M. (2016). *Methods of Data collection*. Curtin University.
- 15) Kelly, S. M., & Smith, D. W. (2011). The impact of assistive technology on the educational performance of students with visual impairments: A synthesis of the research. *Journal of Visual Impairment & Blindness*, 105(2), 73-83.
- 16) *Kilimanjaro Blind Trust*. (2017, October 28). Retrieved February 6, 2021, from Assistive Technology: <https://kilimanjaroblindtrust.org/programs/assistive-technology/>
- 17) Kothari, C. R., & Garg, G. (2014). *Research Methodology: Methods and Techniques*. New Delhi: New Age International Publishers.
- 18) Liu, W., & Wang, C. (2022). Liu, W., & How Roles in Collaboration Respond to the Exchange of Device-Student Ratio Under the Impact of External Scripts? *Educational Technology & Society*, 15 - 30.
- 19) Mugenda, A., & Mugenda , O. (2003). *Research methods quantitative and qualitative approaches*. Nairobi: Act Press.
- 20) Njoroge, M., Njue, S. W., & Chege, F. N. (2014). Braille Competence Among Blind Learners: Materials and Teacher Factors In Thika and Meru, Kenya. *Journal Of Special Needs and Dissability Studies*, 1-8.
- 21) Njue, S. W. (2021). Performance of Learners with Visual Impairment in Summative Evaluation in Special Schools in Kenya. *Global Journal of HUMAN-SOCIAL SCIENCE: G Linguistics & Education*, 14.
- 22) NLS, N. (2021, March 21). *NLS(National Library Service For The Blind And Print Disabled - Library Of Congress)*. Retrieved from Braille Displays and Notetakers: <https://www.loc.gov/nls/resources/blindness-and-vision-impairment/devices-aids/braille-displays-notetakers/>
- 23) Oira, M. A. A. G. A. (2016). Use of modern assistive technology and its effects on educational achievement of Students with visual impairment at Kibos special secondary school Kisumu County, Kenya.



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