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Can Optical Low Vision Devices Improve Reading Outcomes among Learners with Low Vision? A Case of Thika Primary School for theVisually Impaired, Kenya

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Abstract: ***This study sought to establish the influence of optical low vision devices on reading outcome for learners with low vision. The study adopted a quasi-experimental design in which 12 learners with low vision who use print as their main medium for reading and writing from Thika Schoolfor the visually impaired were studied for a period of 9 weeks. A comprehensive low vision assessment to establish appropriate magnificationrequired by learners in the intervention group was conducted before issuing the optical low vision devices. Data on learners' reading speed wascollected by recording the number of words read correctly per minute and the number of errors made during reading. Data on learners' perceived usefulness and ease of use of optical low vision devices werecollected from the intervention group through interviews. Quantitative data wereprocessed using Stata 15 while qualitative data was analyzed thematically. The findings of the study revealed that provision of appropriate optical low vision devices (OLVD) and training learners on their effective use, improve reading outcomes. This was evidenced by a significant increase inthe mean reading speed ofintervention group compared to control group. It was also found that the average number of reading mistakes made by intervention group was lower than the control group. The study recommends that children with low vision should be provided with optical low vision devices and trained on their effective use to improve reading outcomes hence promote access to quality education.***

Keywords: reading outcome, reading speed, low vision, optical low vision devices

1. Introduction

The ability to read print is an essential skill in the 21st century because most information is presented in text; web sites, books, magazines, newspapers, and many other forms of writing. In children, reading is a gateway to knowledge, topacademic performance and attaininga good careerin the future. Consequently, fluency in reading is a very important factor in a child's education. Significant research indicates that children with low vision develop their reading techniques at a slower pace compared to normal sighted peers (Vincent, 2017;Bracher& Mata, 2017; Nguyen, Weismann &Trauzettel, 2009).Principally children with low vision do not attain the same reading speed as their counterparts who are sighted. This happens even when they have the same level of educational and cognitive ability(Glewwe et al., 2016; Latham, 2018).

Several explanations have come up to clarify the phenomenon of reduced reading speed in learners with low vision. The explanations connect the fact to problems that learners with low vision encounter when getting visual information from whichever sources such as printed text. One of the major explanations is the relationship between print type, font size and learners' ability to interpret. To ameliorate this, prescription of optical devices is the most frequent means used to achieve acceptable reading speed (Ramani, Police & Jacob, 2014). Although suitably magnified print provides a remedy for problems with seeing text, it additionally results in fewerletters or phrases that can be fixed at first quick sight. As a result, it requires one to take more glances in order to read a sentence, of which it is time-consuming, and requires one to adapt to use the required optical devices. McCurry et al (2005) averred that training persons with low vision on special reading techniques using optical devices improve reading performance. From a Kenyan context, therefore, this study yields information that can be used by teachers and other stakeholders in the processes of deciding on the provision of optical devices and training children who have low vision on their use in reading.

2. Materials and Methods

A quasi-experimental design was adopted in which 19 learners with low visionwho use print as the main media of reading and writing were assessed for eligibility to participate in thisstudy.The inclusion criteriawere based on two main factors; learnerswho are classified as category three according to Kenyan categorization of persons with low vision and their reading impediment is attributable only to reduced vision but not because of learning difficulty or cognitive impairment.

2.1 Low Vision Assessment of theLearners

Based on the set inclusion and exclusion criteria, 12 learners with low vision were eligible to participate in the study. A comprehensive low vision assessment was conducted on the 12 eligible learners to ascertain distance visual acuity (DVA), near visual acuity (NVA) and magnification required for reading. The DVA was assessed using Lea Test (LH) and ranged from 3/24 to 1/30 while NVA was assessed using Bailey-Lovie near vision chart and ranged between1.0 to 1.6 logMAR.Learners had differentdiagnosis such as; Optic atrophy, acquired nystagmus, retinal dystrophy, cone dystrophy, pseudophakia, coloboma, microphthalmos, optic neuropathy and micro cornea with scars.

2.2 Reading Tasks

Eleven different reading tasks for each class were used for data collection. They were prepared in the English language in Arial font type, size 12 and line spacing of 1.5. Study participants were assigned standard reading tasks with respect to their class. The number of words in the reading tasks assigned to class 4 learners ranged between 134 and 155 (mean=142, sd=7.5) while for class 5 had between 151 and 245 words (mean=171, sd=25.7). Reading tasks for class 6 had between 201 and 216 words (mean=206, sd=4.3) while class 7 had between 151 and 250 words (mean=223, sd=32.9).The number of words in the reading tasks assigned to learners was guided by the oral reading fluency (ORF) technical report (Hasbrouck &Tindal, 2017) published by behavioural research and teaching (BRF). The ORF norms documents the standard number of words read per minute by learners without reading difficulties as follows; between 45 and 180 words per minute for grade 4, between 61 and 194 words per minute for grade 5, between 68 and 204 words per minute for grade 6 and between 79 and 218 words per minute for grade 7.

2.3 Intervention and Control Groups

Study participants were divided into two groups; intervention and control groups. Each learner in the intervention group was issued with an OLVD with appropriate magnificationto enable them to comfortably read critical print size. The partitioning of the sample was purposively done to place six learners in the control group and the other six learners in the intervention group. This was donein a manner that the mean reading speed for each groupis equal at the baseline.

2.4 Training on use of OLVD and Reading Practice

The intervention in this study involved two-hour training and reading practice sessions for seven days. All learners were trained in reading tips and provided with reading materials for practice. Additionally, the intervention group received training techniques on the use of optical low vision devices (OLVD).

2.5 Data Collection Procedures

There were 11 data collection sessions; 2 at the beginning of the study where all learners read their tasks without OLVD and 9 times where learners in the intervention group were using OLVD for reading. The data collection period took place at an equal interval of 2 days. Every data collection involved recording the number of words read by the learner and the number of errors committed. The errors included omissions, substitutions and misreading of words. Data collection at multiple intervals was informed by the study findings by Savaiano and Hatton (2013) who observed that there is a functional relationship between repeated reading and reading speed for learners with low vision.

2.6 Data Analysis

Statistical methods were applied in the analysis of data collected in this study on reading speed. Descriptive statistics such as mean and standard deviation were used to report the number of words read per minute and the number of errors the learner made in the course of reading. An independent t-test was used to test the null hypothesis that there is no significant difference in meanreading speed for learners in the control and intervention group. Regression analysis was used to quantify the impact of OLVD on reading speed for learners with low vision.

3. Results and Discussions

Data collected from all the 12 learners wereanalysed. The descriptive statistics show that 6 learners were female and 6 were male. The mean age of all participants was 13.75 years with a standard deviation of 0.57. In addition, the mean age of learners in the control group was 13.5 years with standard deviation of 0.72 and the mean age for the intervention group was 14 years with standard deviation of 0.93. The distribution of learners per class shows 25% from class 4, 17% from class 5, 25% from class 6 and 33% from class 7 as shown in Figure 1.

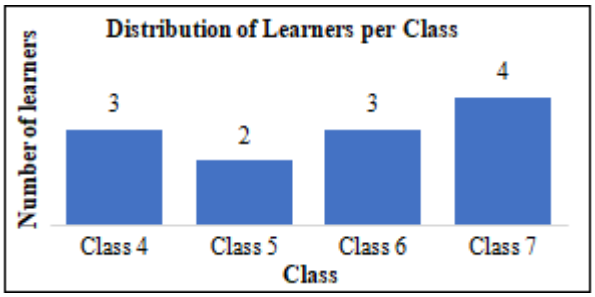

Figure 1: A bar chart for the distribution of learners per class.

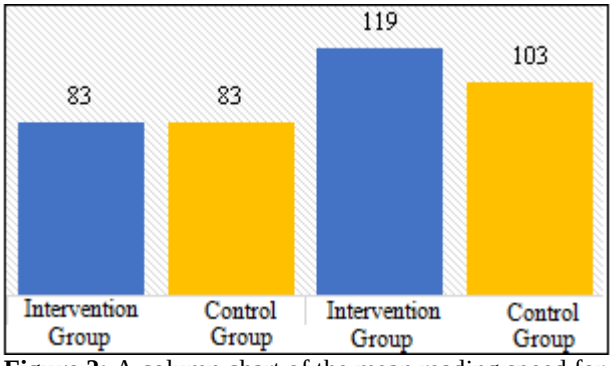

Figure 2: A column chart of the mean reading speed for control and intervention groups

The reading speed for both groups wasequal (83 wpm) before the intervention but increased steadily for both groups, with a significant positive departure for the intervention group as shown in figure 2. It was found that the mean reading speed for learners in the intervention group was higher compared to the control group at every measurement period (figure 3).

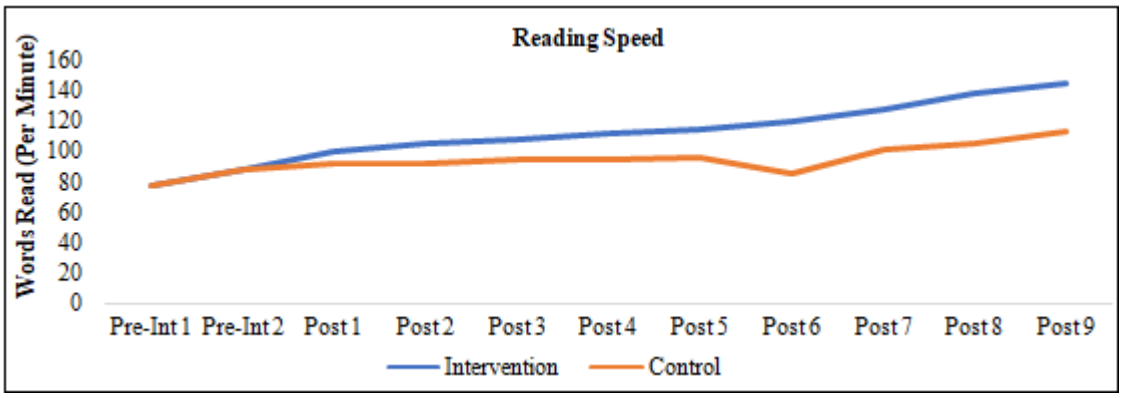

Figure 3: A line plot on reading speed

The hypothesis tests using independent t-test statistics reveal significant differences between the mean reading speed for participants in the intervention group and those in the control group. The hypothesis that there is no difference between the mean reading speed for the intervention and control groups is rejected since $(p = 0.01 < 0.05(one - tailed;\ p=0.02<0.05(two-tailed));$ and $t - statistic = 2.91 > 1.81\ (t - critical)$ at 95% confidence level. Thus, the reading speed of 119 words per minute attained by the intervention group is statistically different from the 103 words per minute attained by the control group. Since the two groups were constituted by learners with low vision, where intervention group used OLVD while the control group did not use, it can be concluded that the use of OLVD improves reading speed for learners with low vision. These findings are supported by (Ramani, Police & Jacob, 2014) study which established that the use of OLVD increases the reading speed by 37 words per minute and also improves reading accuracy and fluency. While other previous studies (Corn, Wall, & Bell, 2000) may have found contradictory evidence with respect to the findings of this study Barker, et al., (2015) argues that manufacturers of OLVD are continuously finding new and better designs which reduce glass weight and increases efficiency of OLVD which may result to improved reading speed in our study.

Table 1: t-test results

	Intervention Group	*Control Group*
Mean Reading Speed (*Words Per Minute*)	118.90	102.57
Variance	75.69	113.16
Observations	6	6
Hypothesized Mean Difference	0	
df	10	
t Stat	2.91	
P(T<=t) one-tail	0.01	
t Critical one-tail	1.81	
P(T<=t) two-tail	0.02	
t Critical two-tail	2.23	

The influence of OLVD (Group) on reading speed of learners with low vision was further assessed alongside other variables of interest such as distance visual acuity (DVA), near visual acuity (NVA), magnification of OLVD, gender, age and class of the learner. Multiple linear regression was used to model the significant predictors of reading speed. The model used in the study was;

$$Reading\ Speed = \beta_0 + \beta_1 DVA + \beta_2 NVA + \beta_3 Gender + \beta_4 Age + \beta_5 Class + \beta_6 Group + \varepsilon$$

where β_0=mean reading speed for a learner with low vision, holding all other factors constant β_i for i = 1,2, ... 6 = regression coefficients, showing the marginal contribution of the i^{th} independent variable in predicting the dependent variable (reading speed).

ε = Stochastic errors in reading speed unaccounted for by the independent variables in the regression model.

The correlation coefficient of determination for the above-specified model ($R^2 = 0.76$) indicates that the specified set of independent variables accounts for 76% of the variation in reading speed. Further model optimization analysis reveals that group (determined by the use or disuse of OLVD) accounts for 64% of variations in reading speed. Table 2 details the summary statistics of the optimal regression model;

$$Reading\ Speed = \beta_0 + \beta_1 Group + \varepsilon$$

This means that DVA (p=0.61>0.05), NVA (p=0.39>0.05), magnification level of OLVD (p=0.57>0.05), gender (p=0.36>0.05), age (p=0.53>0.05) and class (p=0.46>0.05) played an insignificant role determining reading speed. Because of 76% accurate prediction of reading speed, 64% is accounted for by the use of OLVD. These findings are similar to the conclusions made by Lovie, Bevanm and Hein (2001) that reading speed among learners with low vision increases with the use of appropriate magnification devices. This is further supported by Ramani, Police and Jacob (2014) who found that a majority of learners with low vision can achieve similar reading speed as their sighted peers when appropriate magnification is provided. Additionally, (Lovie, Bevanm&Hein, 2001; Ramani, Police & Jacob, 2014) established that near visual acuity (NVA) is a significant predictor of reading speed for learners with low vision. However, near visual acuity (NVA) was not a significant predictor of reading speed in the current study because the reading distance was conveniently adjusted to a suitable position through functional assessment.The regression coefficients for the optimized model arepresented in table 2. From the table, the group (use of OLVD) is a significant predictor (p=0.03<0.05) of reading speed.Therefore, the regression model; Reading Speed =

105.3 + 13.78(Group) indicatesthat the use of the OLVD increased the reading speed by 14 words per minute.

Table 2: Regression coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	105.13	4.08		25.78	0.00
	Group	13.78	5.52	0.639	2.49	0.03
a. Dependent Variable: Reading Speed						

The regression model used to fit the variables of the study is significant (p=0.034<0.05). Out of the total sum of the square of 1266.08, regression (using the group as the only predictor) accounts for 517.52 (40.9%) variation which is significant (p=0.034<0.05). Correlation analysis between reading speed, group (use or disuse of OLVD), gender, age, DVA, NVA, and magnification of OLVD was conducted and results indicate a strong positive relationship between the use of OLVD and the reading speed (p=0.02<0.05; r=0.64). The covariates had no significant effect on the reading speed. (p=0.29;0.18;0.07; 0.20;0.05>0.05).

Additionally, it was found that the mean number of errors committed during reading reduced over time. The number of reading errors committed by learners in the control group reduced by 40% while that of learners in the intervention group reduced by 45%, implying a 5% improvement in reading accuracy. Reading errors for each of the study groups was plotted in figure 4. The intervention groups indicate a consistent reduction in the number of reading errors as opposed to the control group whose variation remains visible even towards the end of the study.

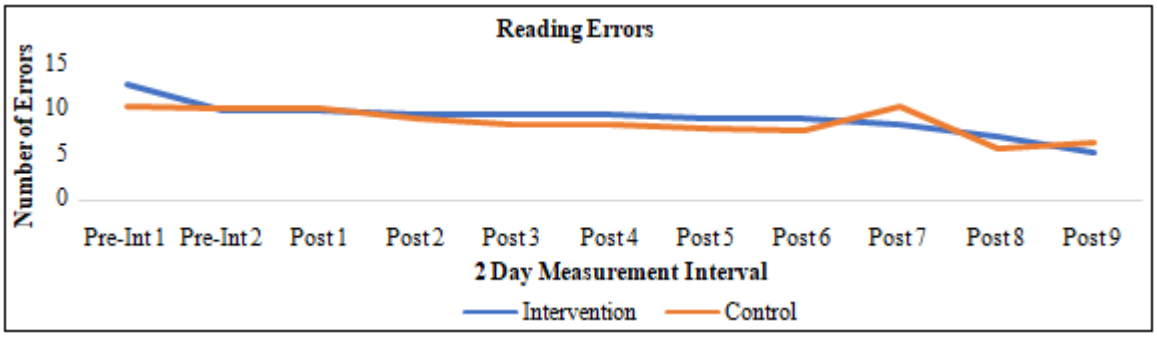

Figure 4: Reading errors plot

The analysis of the perception interview revealed that a majority of the respondents reported thatOLVD wasuseful in reading and writing. Specifically, the interviews revealed a positive attitude of learners with regard to the perceived usefulness of optical devices.

Regarding the ease of use, all the participants found it easy to use.The reason why the learners described the optical devices as being easy is linked with the stated benefits such as increased speed in reading and writing. The majority of the learners were affirmative of their intention to continue using the optical devices. Based on the Technology Acceptance Model, the results suggest that the optical devices are useful and easy to use, hence the intention to adopt and continue using the device.

4. Conclusions and Recommendations

As the prevalence of learners with low vision is increasing and debate on the most appropriate literacy media for learners with low vision in Kenya is raging, this study highlights a number of key issues in relation to the improvement of reading outcomes among learners with low vision. Having shown that use of optical low vision devices is a significant predictor of reading speed in learners with low vision, it is clear that providing optical low vision devices compensate for reduced visual functioning. Therefore, use of OLVDs is an important educational intervention. We therefore propose that learners with low vision can use print rather than braille if provided with the appropriate optical low vision devices. This study further notes that training on the use of the optical low vision devices contributed enormously towards reading performance. Accordingly, it can be concluded that provision of optical low vision devices should be accompanied by training on how to use them.

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