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Effects of Reminder Cards on Students' Achievement in Mathematics among Secondary Schools: A Case of Screen Addiction

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ABSTRACT

The study explored the effects of reminder cards on the mathematics achievement of students suffering from screen addiction in secondary schools. The study adopted the "pretest post-test control group quasi-experimental design". The population for the study consisted of all SSII students in Yenagoa Local Government Area of Bayelsa State, out of which, 131 students from four schools were purposively selected as participants of the study. An intact class from two schools each was randomly assigned to experimental and control groups. The experimental group received treatment using the reminder cards, while the control group did not use reminder cards. Instruments used in the study include the "Screen Behaviour Scale (SBS), Mathematics Achievement Test (MAT), Mental Mathematics Ability Test (MMAT), Guide for Reminder Cards Training, and Instructional Guide for Conventional Mathematics Instruction (IGCMI)." The MAT and MMAT had a reliability of 0.85 and 0.82, respectively, using the Kuder-Richardson Formula 22 (KR-21), while the SBS had a reliability of 0.78 using Cronbach's Alpha. The research questions were analysed through mean and standard deviation, while Analysis of Covariance (ANCOVA) was used to analyse the hypotheses at a 0.05 level of significance. The findings of this study showed that students who used reminder cards had significantly better achievement in mathematics than those who did not. The finding further revealed that mental mathematics ability significantly affected the students' achievement. Based on the findings, it was recommended, amongst others, that reminder cards should be adopted in secondary schools to enhance the learning outcomes of students living with screen addiction.

KEYWORDS: Achievement, Mental Mathematics, Reminder Cards, Screen Addiction

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INTRODUCTION

A subject that cuts across every activity of a man, society, and different fields of study is mathematics. It is the bedrock of modern civilisation, serving as the universal language of science, technology, and innovation (Bailey, 2017; Das, 2020). Its intricate web of concepts and principles provides the essential framework for solving complex problems, modelling real-world phenomena, and advancing fields ranging from engineering to economics. Mathematics cultivates critical thinking, analytical reasoning, and problem-solving skills, enabling us to decipher patterns in data, make informed decisions, and push the boundaries of human understanding (Jayanthi, 2019; VaraidzaiMakondo & Makondo, 2020). Beyond its practical applications, mathematics nurtures intellectual curiosity, fostering a deeper appreciation for the elegance and beauty inherent in the underlying structures of the universe, ultimately shaping our ability to shape the world around us.

Mathematics has a cemented place in the curriculum of any nation, with it typically being a core and compulsory subject, especially at the primary and secondary school levels of education. However, despite the importance of mathematics as a subject, the subject is still attributed as being one of the most difficult to learn by students (VaraidzaiMakondo & Makondo, 2020). Awofala (2017) states that the Nigerian secondary school students had a poor achievement in mathematics at both internal and external examinations, with them not demonstrating a deep-rooted understanding, knowledge and capability to do mathematics. Underachievement in mathematics has been linked to diverse factors over time, ranging from the abstract nature of the subject itself to the instructional strategy being employed to teach the subject (Abreh et al., 2018; Brezavscek et al., 2020). While these factors have been subject to

much attention and research over time, there are still other variables that could further exacerbate learning difficulties in mathematics, but have received considerably less attention. One of such domains of factors is psychological behavioural issues, like dealing with addictions.

Addiction, in simple terms, encompasses the compulsive and typically harmful engagement with substances, behaviours, or activities despite adverse consequences (Zou et al., 2017). These addictions are characterised by an intense craving for the addictive substances or behaviours and a loss of control. It may involve substances like drugs and alcohol or behaviours such as gambling or internet use, and can profoundly impact a person's physical health, mental wellbeing, relationships, and overall quality of life (Felman, 2018; National Institute for Drug Abuse, 2022). A particular focus of this study is to show the effect of addictive behaviours on learning outcomes.

Among others, addictions can impair cognitive abilities, concentration, and disrupt consistent learning patterns, thereby undermining academic performance and potential (Ahmed et al., 2020; Bugbee et al., 2019; Gokcearslan et al., 2016). The socio-emotional consequences of addiction, such as lowered self-esteem and heightened anxiety, also compromise the overall wellbeing of students, hindering their engagement and motivation.

While there exist several types of addictions, in the digital age, there is none as prominent as addiction to digital devices or screens. This is because the widespread use of digital devices and screen time among students has raised concerns about their negative impact on overall wellbeing and academic outcomes. Screen addiction, which has steadily risen due to the ubiquity of digital devices, refers to one characterised by excessive and compulsive use of digital devices (such as smartphones, computers, tablets, and video game consoles), often at the expense of more productive activities, and despite the negative impacts (Singh, 2022). Screen addiction has become especially prevalent among teens and young individuals, as they tend to spend an excessive amount of daily time in front of screens for entertainment (Rideout & Robb, 2019).

Screen addiction impairs learning in diverse ways. Most notably, Students' inability to manage their screen time effectively typically culminates in reduced study hours and decreased focus (amongst others), which will naturally affect their productivity in school and academic achievement. Excessive use of screens has been linked to cognitive impairment, impacting one's capacity to concentrate, think critically, and solve issues (Neophytou et al., 2019).

Furthermore, screen addiction tends to impair sleep. This sleep impairment is due to constant exposure to blue light from screens, which affects the creation of melatonin that regulates sleep (Silvani et al., 2022). Sleep disruptions also tend to occur as addicted students might sacrifice sleep time to be on their digital devices. The sleep disruptions, in turn, mitigate learning in various ways. Among others, it impairs cognitive function and may lead to fatigue during learning activities.

Screen addiction might also hamper social relatedness, as individuals dealing with such addictions spend more time on screens than in social interactions and connections in the real world. Cherry (2023) and Novotney (2019) state that a lack of true and social connections may impact an individual's emotional wellbeing, potentially leading to issues like depression, loneliness, anxiety and even cognitive decline, all of which can further exacerbate learning difficulties.

Thus, considering the prevalence of the screen addiction issue and how it could affect learning, it is essential to explore interventions that could address this issue in educational contexts. One strategy that could address this issue is the use of reminder cards.

Reminder cards are simple, pocket-sized pieces of paper or digital notes that are designed to prompt and remind individuals of tasks, appointments, deadlines, or important information. Panakkal et al. (2018) describe it as simple tools that serve as visual cues to encourage behaviour change. They are also known as memory cards and are sometimes used interchangeably with cue cards.

Functioning as a reminder tool, reminder cards are helpful for managing daily tasks and project deadlines, helping individuals stay organised and prioritise their work effectively (TaskOPad App, 2023). Reminder cards could also help enhance memory, as writing down information or tasks and having a visual reminder can significantly enhance recall (Murphy, 2018; Zoe, 2022). Furthermore, reminder cards are also useful for boosting productivity, as having a clear visual representation of what needs to be done is likely to make one stay focused and complete tasks efficiently, as well as reduce procrastination.

In the context of this study, reminder cards are useful as they could help students stick to academic commitments and reduce the amount of time spent on screens. For learning purposes, reminder cards posted around the environment of students provide them with a structured and visually engaging tool that can help them maintain a consistent study schedule. These cards can also be used in the form of flashcards or concise study notes and serve as memory aids, enabling learners to condense complex information, improve retention, and quickly review critical material.

Other than their personal study, reminder cards could also be used actively by students in the classroom. For instance, students in the class can make use of reminder cards to write down contents (e.g. very short snippets, mnemonic acronyms, among others) that will trigger recall of what the teacher is teaching. These cards can help students retain and recall information more effectively, as they can serve as quick reference guides for future use.

Particularly relevant is the potential functionality of reminder cards in managing screen addiction among students. It is functional as it could provide individuals with tangible and consistent visual cues to regulate their screen time. These cards can be strategically

placed around an individual's environment (home and school), reminding users of their goals to reduce screen use, reclaim their time, and do something more productive with their time, like studying. Physical cards placed in prominent and noticeable locations can be used for this purpose; they can be further enhanced by utilising digital reminder cards, which show up on the digital devices of the students continually. This is useful as having reminders pop up on the screen at scheduled times, reminding the individual to get off the phone, will likely prove more effective than just continually seeing the reminder on a wall. Through these simple yet effective prompts, reminder cards can empower individuals to break the cycle of screen addiction and invest more time in academic commitments. Thus, reminder cards in the context of this study serve a triple function, which is reminding and encouraging students to study, used as a visual learning or memory aid by storing bite-sized learning contents, and helping students manage their screen time usage.

Students' achievement and learning of mathematics can be further affected by a series of other variables. One of these is their existing knowledge or skills, like their mental mathematics ability. The mental mathematics ability refers to cognitive skills that allow individuals to perform calculations in their minds without using a calculator or a pen (Mat, 2023). It relies on cognitive faculties like memory, visualisation, and pattern recognition (Matin-ao & Timario, 2021). Being a mathematics-centred skill, it is easy to see how these skills or abilities could affect students' achievement in mathematics, and may even affect the overall effectiveness of interventions like the use of reminder cards.

This study thus investigated the effect of reminder cards on students' achievement in mathematics among secondary schools, specifically focusing on their role in mitigating the challenges posed by screen addiction. The study also observes the moderating effects of mental mathematics ability on the dependent variable.

This study is supported by the Habit Loop Model, also known as the Cue-Routine-Reward model. This theory explains that habits form when a specific cue triggers a routine behaviour that is followed by a rewarding outcome, which reinforces the cycle over time (Chen et al., 2020; Raypole, 2021). The theory is relevant to this study as the use of reminder cards functions as a behaviour cue. In this context, the cues (reminder cards) are used to strengthen or enhance one behaviour (studying) and also reduce another (excessive screen use). Thus, the cards act as cues, studying is the desired habit being reinforced, and the cues also help disrupt screen-related habits, so the reward of personal satisfaction, accomplishment, as well as enhanced learning can be achieved.

STATEMENT OF THE PROBLEM

Digital technologies and screens have become an integral part of the daily lives of individuals across all walks of life, including secondary school students. However, the extensive use of screens, particularly for recreational purposes, is a concern to many stakeholders as it leads to the development of an addiction, which can impact students' academic achievement in essential subjects like mathematics. Thus, there is a need to explore and assess potential interventions to address this due to the high prevalence of screen addiction among students. Reminder cards are one such intervention that could help students manage their screen time more effectively and also enhance their mathematics learning process. However, the use of reminder cards as an intervention remains underexplored, with most studies on reminder cards focused solely on health behaviours rather than enhancing learning among addicted students. This study, therefore, explores the effect of reminder cards on the mathematics achievement of secondary school students. The study also examines the moderating effects of mental mathematics ability on the dependent variable.

RESEARCH QUESTIONS

The following research questions guided the study for data collection.

1. What is the difference in the mathematics mean achievement score of students suffering from screen addiction who used reminder cards and those who did not?
2. What is the difference in the mathematics mean achievement score of high and low mental ability students who used reminder cards and those who did not?

NULL HYPOTHESES

The following null hypotheses were tested at 0.05 level of significance.

1. There is no significant difference in the mathematics mean achievement score of students suffering from screen addiction who used reminder cards and those who did not.
2. There is no significant difference in the mathematics mean achievement score of high and low mental ability students who used reminder cards and those who did not.

METHODOLOGY

This study adopted a "pretest, post-test control group quasi-experimental design." The population of this study comprised all students in their second year of senior secondary school (SS II) in Yenagoa Local Government Area of Bayelsa State. A purposive sampling

technique was used to select four public secondary schools for this study. The selection of schools was based on the following criteria: "the schools must be public secondary schools, the mathematics teachers in these schools must be professionally qualified, and must have been teaching mathematics for a minimum of four years, the teachers and authorities of the school must be willing to be involved and make provisions for the study". A class from each school was further selected, and only students who demonstrated screen addiction participated in the study. Two schools each were randomly assigned to the experimental or control group, making a total of four schools selected for the study.

Three instruments were developed to be used in the study for data collection. These include: "Screen Behaviour Scale (SBS), Mathematics Achievement Test (MAT), and Mental Mathematics Ability Test (MMAT). Also, two instructional guides such as Guide for Reminder Cards Training (GRCT), and Instructional Guide for Conventional Mathematics Instruction (IGCMI)". The SBS was used to measure students' screen usage habits and identify those with screen addiction. The MAT was a test instrument designed to measure students' achievement in mathematics. The MMAT was used to measure students' mental mathematics ability, and the scores were used to sort students into categories of high and low mental mathematics ability. The GRCT was used to train the students and teachers in the experimental group on how they could properly use reminder cards to help manage addiction and enhance learning. The IGCMI was a teaching guide used to teach mathematics in the classroom during the period of data collection (for both experimental and control groups). All of the instruments received face and content validity through expert review. The MAT and MMAT had a reliability of 0.85 and 0.82, respectively, using the Kuder-Richardson Formula 21 (KR-21). The SBS had a reliability of 0.78 using Cronbach's Alpha.

The data collection process lasted for seven weeks and took place after the selection of schools and obtaining permission from the schools' head teachers. The first week of data collection was used to train mathematics teachers from the selected schools to function as research assistants. At the start of the second week, the SBS was administered to the students to identify those with a screen addiction problem, who became the sample of the study. The third week was used to administer the MAT and MMAT to the screen addicted students as a pretest. During the fourth week, the students in the experimental group received training on how to use reminder cards through the GRCT. Also, the teachers in the experimental group received the training to keep guiding the students. Students were also given adhesive-backed papers (sticky notes) to use as reminder cards, and then they were tasked to use the reminder cards for the next two weeks. The fifth and sixth weeks of data collection were used for classroom instruction for both students in the experimental and control groups using the IGCMI. However, students in the experimental group made use of reminder cards during this period while those in the control group did not. The MAT was then re-administered to the students during the seventh week to get their post-test scores. Data was analysed using mean and Standard deviation for the research questions and Analysis of Covariance (ANCOVA) to test the null hypotheses at 0.05 level of significance.

RESULTS

Research Question One: "What is the difference in the mathematics mean achievement score of students suffering screen addiction who used reminder cards and those who did not?"

Table 1: Summary of Mean and Standard Deviation of students' Pretest and Post-test Scores Showing the Effects of Treatment on the Mathematics Achievement Scores of Students suffering from Screen Addiction

Intervention	N	Pretest Scores		Post-test Scores		Mean Gain
		Mean	SD	Mean	SD	
Reminder Cards	64	24.5	6.7	56.75	10.73	32.25
No Reminder Cards	67	23.64	6.78	44.78	5.62	21.14
Total	131	24.06	6.73	50.63	10.39	26.57

Table 1 shows that students who used reminder cards had a greater mean post-test mean score (Mean = 56.75, SD = 10.73) than those who did not use reminder cards (Mean = 44.78, SD = 5.62). The table further shows that the mean gain score of students who used reminder cards (32.25) was greater than that of students who did not (21.14). Consequent upon the observed differences, ANCOVA was carried out to ascertain if the observed difference was statistically significant.

Research Question Two: "What is the difference in the mathematics mean achievement sore of high and low mental ability students who used reminder cards and those who did not?"

Table 2: Summary of Mean and Standard Deviation of Pretest and Post-test Scores showing the effects of treatment on the High and Low Mental Mathematics Ability Students' Achievement scores in Mathematics, suffering from Screen Addiction

Treatment	Mental Math	N	Pretest Scores		Post-test Scores		Mean Gain
			Mean	SD	Mean	SD	
Reminder Cards	**High**	18	21.78	5.86	60.22	13.41	38.44
	Low	46	25.57	6.77	55.39	9.31	29.82
	Total	64	24.5	6.7	56.75	10.73	32.25
No Reminder Cards	**High**	23	23.48	6.75	49.22	4.42	25.74
	Low	44	23.73	6.87	42.45	4.74	18.72
	Total	67	23.64	6.78	44.78	5.62	21.14
Total	**High**	41	22.73	6.35	54.05	10.85	31.32
	Low	90	24.67	6.84	49.07	9.85	24.4
	Total	131	24.06	6.73	50.63	10.39	26.57

Table 2 shows that for students who made use of reminder cards, the post-test mean score of students with high mental mathematics ability (Mean = 60.22, SD = 13.41) was greater than that of students with low mental mathematics ability (Mean= 55.39, SD = 9.31). Similarly, for students who did not use reminder cards, the post-test means scores of students with high mental mathematics ability (Mean = 49.22, SD = 4.42) were greater than those of students with low mental mathematics ability (Mean = 42.45, SD = 4.74). The total post-test mean score of students with high mental mathematics ability (Mean = 54.05, SD = 10.85) was greater than that of students with low mental mathematics ability (Mean = 49.07, SD = 9.85). The table further shows that the total mean gain score of students with high mental mathematics ability (31.32) was greater than that of students with low mental mathematics ability (24.4). Consequent upon the observed differences, ANCOVA was carried out to ascertain if the observed difference was statistically significant.

Null Hypothesis One: "There is no significant difference in the mathematics mean achievement score of students suffering screen addiction who used reminder cards and those who did not."

Table 3: One-way Analysis of Covariance of the Post-test Mathematics Achievement Scores of Screen Addicted Students who used Reminder Cards and those who did not

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4734.084[a]	2	2367.042	32.556	.000	.337
Intercept	22323.505	1	22323.505	307.031	.000	.706
Pretest	41.054	1	41.054	.565	.454	.004
Treatment	4617.920	1	4617.920	63.513	.000*	.332
Error	9306.588	128	72.708			
Total	349792.000	131				
Corrected Total	14040.672	130				

a. R Squared = .337 (Adjusted R Squared = .327); *sig at $p < 0.05$

The result in Table 3 shows that there is a significant main effect of treatment on students' achievement in mathematics, $F(1, 128) = 63.513$, $p < 0.05$, partial eta squared = .332. This gives an effect size of 33.2%. Thus, the null hypothesis, which states that "there is no significant difference in the mathematics mean achievement score of students suffering screen addiction who used reminder cards and those who did not", was rejected.

Null Hypothesis Two: "There is no significant difference in mathematics mean achievement score of high and low mental ability students who used reminder cards and those who did not."

Table 4: Two-way Analysis of Covariance of the Post-test Mathematics Achievement Scores of High and Low Mental Mathematics Ability Students who used Reminder Cards and those who did not

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5785.604[a]	4	1446.401	22.077	.000	.412
Intercept	22073.451	1	22073.451	336.915	.000	.728
Pretest	99.822	1	99.822	1.524	.219	.012
Treatment	3988.245	1	3988.245	60.874	.000	.326
Mental Math	1005.074	1	1005.074	15.341	.000*	.109
Treatment * Mental Math	14.684	1	14.684	.224	.637	.002
Error	8255.068	126	65.516			
Total	349792.000	131				
Corrected Total	14040.672	130				

a. R Squared = .412 (Adjusted R Squared = .393); *sig at $p < 0.05$

The result in Table 4 shows that there is a significant main effect of mental mathematics ability on students' achievement in mathematics, $F(1, 126) = 15.341$, $p < 0.05$, partial eta squared = .109. This gives an effect size of 10.9%. The table, however, shows that there is no significant interaction effect of mental mathematics ability and treatment. Thus, the null hypothesis, which states that "there is no significant difference in mathematics mean achievement score of high and low mental ability students who used reminder cards and those who did not", was rejected.

DISCUSSION OF FINDINGS

The findings of the study showed that there is a statistically significant difference in the mathematics mean achievement score of students suffering screen addiction who used reminder cards and those who did not, in favour of those who used reminder cards.

This finding agrees with that of Khairunnisa (2017) study which explored the use of cue cards as media to improve the speaking achievement of eleventh-grade students and reported that students who were taught by using Cue Card media had significantly better improvement than those taught without cue cards. The findings also agree with Siregar (2017), who assessed the effects of cue cards on students' achievement in writing procedure text and reported that there was a significant effect of using cue cards on students' achievement in writing procedure text. Further, the findings also agree with the studies by Amiruddin and Razaq (2022) and Ma'rifah and Suhaimi (2020), which explored how the use of flashcards affected students' vocabulary achievement and reported that employing flashcards significantly boosted pupils' vocabulary achievement.

A series of factors may have contributed to this finding. Constantly reviewing content is likely to make one fully master it. While the reminder cards did not contain all the full contents learned in the class, they contained and highlighted key areas, and the students were guided to post them around places where they constantly come in contact with. Thus, the students are constantly exposed to key concepts, which would have likely triggered their knowledge of other related content learned in class, that is not even listed on the card. Furthermore, the students making use of reminder cards in the class highlighted key areas while teachers explained concepts, giving them something active to do, rather than just listening, which has likely increased their interest and hence enhanced their comprehension. Having written the cards themselves, constantly seeing them likely triggered their memories of using them in the class and related to more content learned inside the class.

Also, the use of the reminder cards as 'action reminders' to remind screen-addicted students to put down their devices or screens and participate in academic and learning activities like doing assignments and studying, making them more likely to perform those tasks than students without a similar reminder system.

The findings of the study showed that there is a significant difference in the mean mathematics achievement score of high and low mental mathematics ability students who used reminder cards and those who did not, in favour of students with high mental mathematics ability. This finding agrees with that of Korpershoek et al. (2015), which assessed the relationship between the mathematical ability of students and their achievement in chemistry, physics and mathematics in secondary schools and reported that the mathematical ability of the students significantly affected their achievement in chemistry, physics and mathematics. This finding also agrees with that of Abubakar et al. (2023), who assessed mathematical ability as a predictor of academic performance in chemistry among undergraduate students and reported that there is a positive relationship between mathematical ability and the academic performance of chemistry students. The findings further agree with those of Hassan and Bello (2022), who explored the influence of mathematical ability on senior secondary school students' achievement in physics and reported that the mathematical ability of students significantly influenced their achievement in physics.

CONCLUSION

From the findings of the study, it can be concluded that reminder cards are effective for enhancing the mathematics achievement of students living with screen addiction. Also, students' achievement in mathematics is significantly influenced by their mental mathematics ability, irrespective of whether they used reminder cards or not.

RECOMMENDATIONS

The following recommendations are proposed:

1. Teachers should adopt the reminder cards intervention for teaching students, especially those with addiction issues.
2. Teachers should understand the issue of screen addiction in learning contexts and how strategies like reminder cards could help address those issues.
3. Government and other educational authorities should organise in-service training in the form of workshops and seminars focusing on issues that could disrupt learning, like screen addiction, and how to implement innovative tools and strategies.
4. Higher institution teacher training programmes should make provisions for equipping future teachers with knowledge of psychological and behavioural issues that can affect learning, like screen addiction, and strategies to address the issues, like the use of reminder cards.
5. Teachers should explore interventions to enhance students' general mathematical skills, such as mental mathematics ability, as this could affect their achievement.

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