

Science Students' Exposure to Non-Ionizing Radiation in Educational District IV, Lagos, Nigeria: Implications for Physics Curriculum Review

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Abstract

Non-ionizing radiation (NIR) is usually not considered a significant health risk. However, continuous exposure to them might in the long run result in some health issues such as tissue heating, sunburns, skin reddening, vision loss, etc. Therefore, this study examines students' exposure to non-ionizing radiation and its implications on the Physics curriculum. The research design was a descriptive survey design, and the population of the study comprised all the SS2 students in the educational district (IV) in Lagos State, Nigeria. The study sample was one hundred and twenty students randomly selected from five (5) randomly selected secondary schools. A researcher-designed checklist was used to assess students' exposure to NIR, while students' knowledge of applicable Physics knowledge was assessed using questions extracted from standardised examination questions (WAEC). The data collected were analysed using descriptive statistics of frequency counts, percentages, and inferential statistics of correlation. The results from the data analysis revealed that a negative and non-significant correlation ($r = -.06$, $p = 0.513$) existed between the students' exposure period to NIR and the Physics achievement test; also, 83.33% of the study sample (100 students) were daily exposed to all ten NIR gadgets used in this research, among others. Hence, some of the recommendations from the study are that Physics concepts should be taught in a more applied manner for the students to be able to apply science to real-life situations, and that the physics curriculum should be more inclusive to be able to bring about a change in the behaviour of learners after undergoing learning instructions.

Keywords: Radiation Exposure, Non-Ionizing Radiation (NIR), Curriculum, NIR Gadgets

Introduction

One of the key purposes of acquiring knowledge in any subject is to enable learners to apply and relate such knowledge to their environment (Cukurova, Bennett & Abrahams, 2017). Consequently, studying science at the secondary school level goes beyond mere memorization of facts, recall of routines, or rote learning. It involves developing an understanding of the natural

world by making its concepts less vague, magical, and mysterious, but more logical, coherent, and realistic (Shtulman & Walker, 2020; Silva, 2022).

In addition, science education fosters the development of critical thinking skills, which support informed decision-making (Wood, 2023). It also stimulates curiosity, encourages innovation, and inspires creativity. Furthermore, it promotes environmental awareness, thereby enabling learners to adopt healthy and responsible lifestyles, among other benefits (Krauss, 2024).

The curriculum, as a structured plan for teaching and learning within the educational system, serves as a guide for both teachers and learners in achieving educational objectives. From the learners' perspective, it is designed to equip them with relevant knowledge and skills for their future lives, inculcate societal values, and facilitate the development of the cognitive, affective, and psychomotor domains necessary for both personal and societal growth.

Physics, a core science in the secondary school curriculum, is a scientific discipline governed by laws, theories, and principles (Hjorland, 2021) that explain the relationship between matter and energy. Radiation is energy transmitted as waves or particles through space, and it exists all around us. Non-ionizing radiation (NIR), a category of radiation, is a low-frequency radiation (Ruschena & Ralph, 2019) generated by electric, magnetic, and electromagnetic fields (physics concepts), time-varying (up to 300 GHz) from sources such as mobile phones, microwave ovens, computers, video games, televisions, light bulbs, e.t.c (Gherar, Ciuti, Tognarelli & Cinti, 2014; ICNIRP, 2020) which are day-to-day gadgets around us. It is generally considered to pose minimal health risks, but prolonged or continuous exposure may, over time, lead to health effects such as tissue heating, sunburn, skin reddening, possible vision impairment, and others (ICNIRP, 2020; Lahir, Y.K., 2023; Abrar et al., 2025).

The potential hazards associated with non-ionizing radiation depend largely on the duration of exposure and the energy intensity of the sources involved. Runak, Abdulrahman, and Ismael (2017) worked on some electromagnetic devices, such as different mobile phones and cell towers, and warned that the increased use would have an extremely negative effect on human health.

The fundamental principles underlying radiation, including its nature, sources, and modes of transport, are embedded in Physics concepts from the senior secondary school level. It is therefore expected that exposure to these concepts, as recommended by the curriculum, should result in positive attitudinal changes in learners regarding radiation and its safe interaction with the environment. Hence, this study aimed to measure the effect of physics instruction on learners' behaviour regarding exposure to non-ionizing radiation from some of its sources.

Research Question

1. How many of the outlined non-ionizing radiation gadgets are students exposed to?
2. What is the level of exposure of students to non-ionizing radiation gadget sources with reference to time?

Research Hypothesis

H₀: There will be no significant relationship between knowledge of physics principles and students' exposure to non-ionizing radiation.

Methodology

A simple descriptive correlation design was adopted for this study. The entire population of this study consisted of all the science students in Educational District IV in Lagos State. A two-stage random sampling technique was used to select five (5) senior secondary schools and twenty-four (24) students from each school to make a hundred and twenty (120) study sample. The 10 NIR emitting gadgets used in this study were randomly selected among those that can be found in our homes, in our environment and at schools. They are: television, radio, projector, microwave oven, Android phone, laptop, desktop, power line, light bulb, and telecommunications mast. Two research instruments were used for the study, they: a checklist on NIR gadgets and usage, and an

Achievement Test on Radiation Physics Principles (ATRPP). Two experts from the Physics department validated these instruments, and necessary amendments were made. The ATRPP consisted of selected radiation-principle items adapted from standardized West Africa Examination Council (WAEC) examination questions. To determine the internal consistency of the adapted items within the present study, Cronbach's alpha was computed, yielding a reliability coefficient of 0.79, which indicates that the instrument possesses acceptable reliability.

The data collected was analyzed using both descriptive and inferential statistics. Frequency counts, ranges, percentages, and Pearson product-moment correlations were used to analyze the data, and simple bar charts were also used to present some of the results.

Results

Research Question 1: What non-ionizing radiation gadgets are students exposed to?

Table 1: Number of NIR gadgets that students are exposed to

| No. of Gadgets being exposed to | No. of students exposed to gadgets | No. of students exposed to gadgets % |
|---------------------------------|------------------------------------|--------------------------------------|
| 10 | 100 | 83.33 |
| 9 | 2 | 1.67 |
| 8 | 1 | 0.83 |
| 7 | 6 | 5 |
| 6 | 4 | 3.33 |
| 5 | 1 | 0.83 |
| 4 | 6 | 5 |
| 3 | 0 | 0 |
| 2 | 0 | 0 |
| 1 | 0 | 0 |

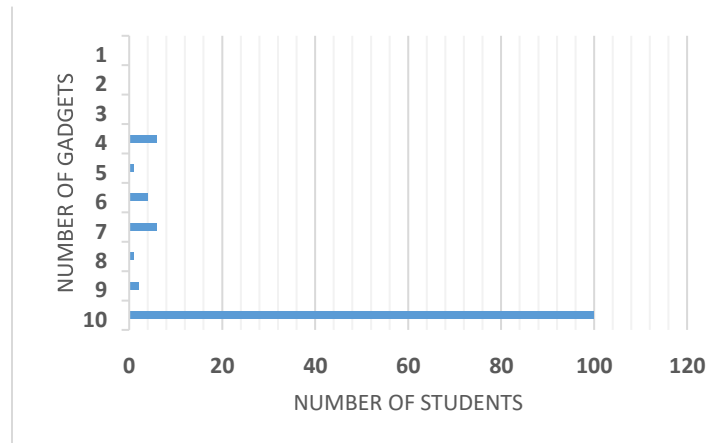


Figure 1: Plot of some NIR gadgets vs number of students.

Figure 1 above is the graphical representation of Table 1. The figure revealed that a hundred students representing 83.33% of the study sample were exposed to all the ten (10) NIR gadgets considered in this study, 6 students were exposed to seven and four NIR gadgets representing 5% each of the study sample, four students representing 3.33% of the study sample are exposed to six of the considered NIR gadgets, two students, 1.67% agreed to nine of the gadgets and 1 student, representing 0.83% agreed to being exposed to eight and five NIR gadgets respective. However, there were indications of no exposure to only one, two, or three NIR gadgets. The least number of NIR gadgets exposed for this study is four.

Research Question 2: How would the level of exposure of students to non-ionizing radiation gadgets sources be estimated with reference to time?

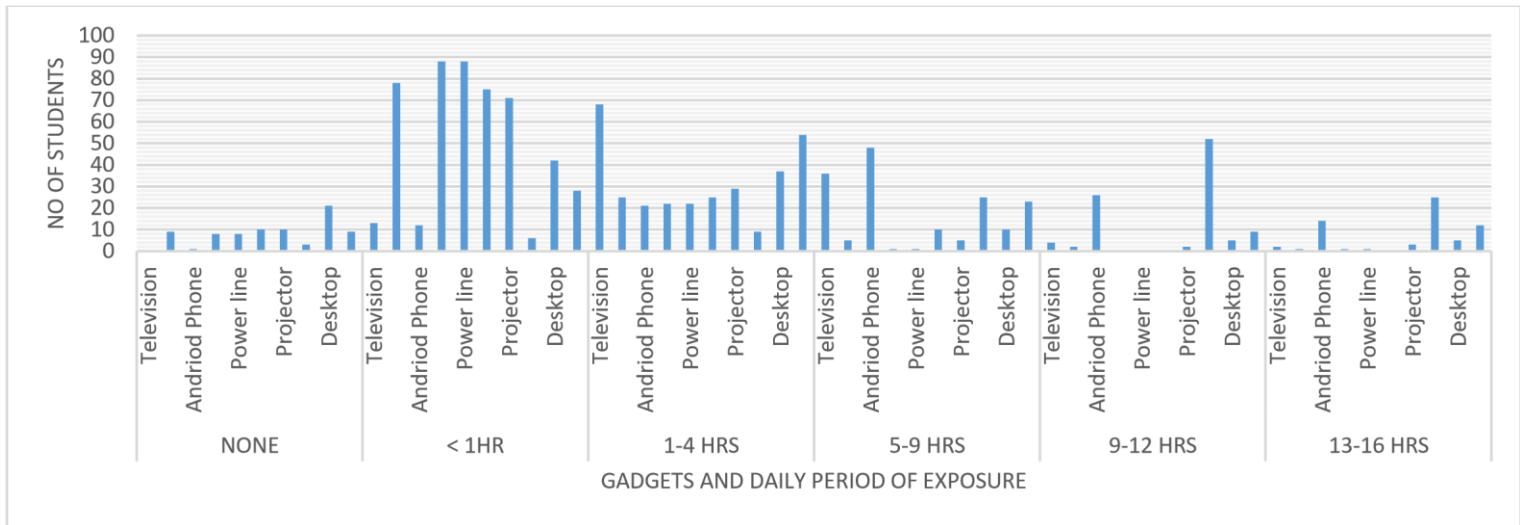


Figure 2: Plot of Gadgets and the daily exposure period of students

From fig. 2, the daily exposure period to television radiation had the highest period of exposure for the 1-4 hours exposure period with 68 students, who made 56.67% of the study sample, 36 others, 30% of the study sample, spent 5-9 hours daily to radiation exposure from the television set. 13 students, 10.83% of the study sample spend less than one hour daily with the television set and others with exposure duration of between 9-12 hours and 13-16 hours represent less than 4% of the entire study sample. However, no student indicated any daily exposure to the television set.

For radio radiation, the highest period of exposure is less than one hour, with 78 students, who made 65% of the study sample. 25 students, 20.83% of the study sample, indicated 1-4 hours daily exposure to the radio set; the higher exposure periods of 5-9 hours, 9-12 hours and 13-16 hours had 5, 2, and 1 student respectively, with a cumulative percentage below 10% of the entire study sample. But, 9 students among them, still, 7.5% of the study sample are not exposed to radio radiation at all.

The daily exposure period to an Android phone had the highest period of exposure of 5-9 hours, with 48 students, who made 40% of the study sample. 26 students, 21.67% of the study sample indicated 9-12 hours daily exposure to android phone, 21 students, 17.5% of the study sample indicated 1-4 hours daily exposure to the android phone, 14 students, 11.67% of the sample study indicated 13-16 hours daily exposure to android phone, 12 students, 10% of the study sample indicated 1-4 hours of daily exposure. But one student indicated no exposure to an Android phone radiation at all.

For microwave oven radiation, the highest exposure time is < 1 hour, and 88 students agreed to this slot, while the lowest exposure time of 9-12 hours had zero student representation. However, the powerline radiation daily exposure period showed the highest period to be less than one hour exposure time with 88 students, who made 73.33% of the study sample. 22 students, 18.33% of the study sample, indicated 1-4 hours daily exposure to the powerline radiation; the higher exposure periods of 5-9 hours, 9-12 hours, and 13-16 hours had 6 students in total, and they altogether had a percentage below 5% of the entire study sample. But, 8 students among them still, 6.67% of the study sample, are not exposed to powerline radiation at all.

The daily exposure period to projector radiation had the highest period of less than one hour exposure time, with 71 students, who made 59.16% of the study sample. 29 students, 24.16% of the study sample indicated 1-4 hours daily exposure to the projector set. The higher exposure period of 5-9 hours, 9-12 hours and 13-16 hours had 5, 2 and 3 students respectively and they altogether had a percentage below 10% of the entire study sample. But, 10 students among them still, 8.33% of the study sample are not exposed to projector radiation at all.

Light bulb gadget reveals the daily exposure period of 9-12 hours as the highest exposure time with 52 students, making 43.33% of the study sample. 25 students, 20.83% of the study sample indicated 5-9 hours daily exposure to the light bulb radiation, another 25 students. Also 20.83% of the study sample indicated 13-16 hours of exposure to the light bulb radiation. The lower exposure period of 1-4 hours and less than one hour has 9 and 6 students respectively, which

altogether make up 12.5% of the study sample. While 3 students are not exposed to light bulb radiation at all.

For desktop radiation, the highest period of exposure is less than one hour, with 42 students, who made 35.83% of the study sample. 37 students, 30.83% of the study sample indicated 1-4 hours daily exposure to the desktop radiation; the higher exposure period of 5-9 hours, 9-12 hours and 13-16 hours had 10, 5 and 5 students respectively and they altogether had a percentage below 17% of the entire study sample. Also, 21 students among them, 17.5% of the study sample are not exposed to desktop radiation at all.

Laptop gadget on the plot revealed the highest period of exposure as the 1-4 hours, with 54 students, who made 45% of the study sample. 28 students, 23.33% of the study sample indicated less than one hour of daily exposure to the laptop, with 23 students, 19.16% of the study sample indicated 5-9 hours of exposure to the laptop radiation. The higher exposure period of 9-12 hours and 13-16 hours had students in total and they altogether had a percentage below 13% of the entire study sample. But, 9 students among them, still, 7.5% of the study sample are not exposed to laptop radiation at all.

Testing of Hypothesis: There will be no significant relationship between knowledge of physics principles and students' exposure to non-ionizing radiation.

Table 2: Physics achievement test score grade grouping

| GRADE | SCORES |
|-------|--------|
| A | 74 |
| B | 30 |
| C | 12 |
| D | 0 |
| E | 0 |
| F | 4 |

KEY: Grade A- 70 and above
 Grade B - 60- 69
 Grade C - 50-59
 Grade D - 45-49
 Grade E – 40-44
 Grade F- Below 40

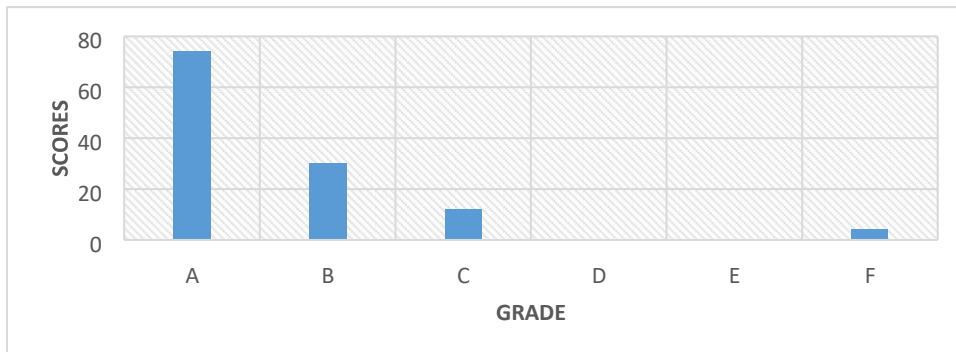


Figure 3: Plot of Physics achievement test scores by grade

Table 3: Correlation table for exposure level and Physics achievement

| | | Exposure Period | Physics Achievement |
|---------------------|------------------------|--------------------|---------------------|
| Exposure Period | Pearson Correlation | 1 | -0.06 |
| | Sig. (2-tailed) | | 0.513 |
| | N | 120 | 120 |
| Physics Achievement | Pearson Correlation | -0.06 | 1 |
| | Sig. (2-tailed) | 0.513 | |
| | N | 120 | 120 |

Table 3 is the correlation result between students' exposure period and the physics achievement test. From the table, it is shown that there is a negative and non-significant correlation between the two variables, $r = -.06$, $n=120$, $p= 0.513$. Hence, there is no significant correlation between the exposure period and students' physics achievement.

Discussion of Findings

From the determination of the level of exposure of these students to NIR, it was revealed from the checklist used that a hundred students, which made 83.3% of the study population, were exposed to all ten gadgets. NIR gadgets could be agreed to be day-to-day simple machines, relaxation and technological devices that make life a bit easier for us, hence the need for them around us. Their presence and usage, however, make us liable to their potential hazards, premised on the duration of exposure and the energy intensity of the sources involved. This aligns with the findings of Runak, Abdulrahman, and Ismael (2017) that the increased use of electromagnetic gadgets would have a great negative effect on human health.

The time spent during these exposures was also determined, with students supplying estimated daily exposure duration to each gadget. Six of the gadgets examined: radio, powerline, microwave, telecom mast, projector, and desktop had a daily exposure duration of about < 1 hour. This estimation appears possible for secondary school students who would spend most of their active time at school, where most of these gadgets are not present. For television and laptops, the highest time spent fell between 1 and 4 average hours daily. This also looks possible with secondary school students who would spend 8 a.m to perhaps 4 p.m in school daily. Exposure to an Android phone had a maximum time duration of between 5 and 9 hours daily. This does not align with students' daily work plan of 8 hours in school, and 8 hours to sleep. Since phones are not allowed in schools, the possibility of spending 5 to 9 hours on phones might imply that they sneaked them into school, or they spent part of their bedtime using the phone. This is in line with the report of Runak, Abdulrahman, and Ismael (2017), warning against the increased use of mobile phones. The 10th gadget, the light bulb, accounted for the highest period of between 9 to 12 hours. This attests to the unconservative turning on and leaving on light bulbs even when they are not needed. This negates the objectives of some physics concepts, such as energy, light, and waves.

The correlation test between students' exposure period and Physics achievement showed a negative and not significant relationship. This implies that students' attitude to NIR exposure duration, despite their knowledge of physics principles regarding the energy and waves generated, did not align with the expected learning objectives as designed by the curriculum after exposure to these Physics concepts, hence, a need for a review. This agrees with Omer's (2021) recommendations of understanding the risks/benefits of radiation by studying the physics behind it. Abrar et al. (2025) also expanded on the different effects of radiation, which must be understood to have the right attitude.

Conclusion

The study revealed high levels of students' exposure to non-ionising radiation, with no significant relationship between exposure and physics achievement, indicating a gap between knowledge and behaviour and highlighting the need for curriculum improvement to promote practical application and safe radiation practices.

Recommendations

1. Physics concepts should be taught using practical, real-life applications to enhance students' ability to translate knowledge into safe behavioural practices.
2. The physics curriculum should be reviewed to incorporate more context-based and behaviour-oriented learning outcomes related to radiation exposure.
3. Awareness programs should be introduced in schools to educate students on the risks of prolonged exposure to non-ionizing radiation and promote safer usage of electronic devices.

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