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Frequent utilization of visuals and effects on learners' academic achievement in physics in secondary schools in Kiambu county, Kenya

[1]P. Archimedes Dahn, [2] Dr Michael Waititu
[1]Master of Physics Education (Educational Communication and Technology)
School of Education, Kenyatta University
[2]Department of Educational Communication and Technology
Kenyatta University
Email: [1]Parchimedesdah@gmail.com, [2]Waititu.michael@ku.ac.ke,

Abstract: *The study investigated the frequent utilisation of visuals and their effects on learners' academic achievement in Physics in Secondary schools. The study was guided by Piaget's Cognitive Theory and supported by Bernice Rogowitz's Visualisation Theory. A descriptive research method was employed in the study, designed with mixed methods of data collection. The study targeted public secondary schools in Thika East, Kiambu County. The public schools were stratified as county and sub-county schools. The study used a questionnaire and an observation checklist as data collection instruments. The study achieved the following objectives: to find out how frequently visuals are utilised in teaching physics and the effects of visuals on learners' academic performance in Physics in secondary schools. The study targeted five Physics teachers and 294 students in Form Two (Grade 10). The finding will help the government of Kenya enrich teacher training by making it more practical than theoretical as the country implements competency-based curricula (CBC). The CBC envisions that at the end of the learning period, every learner should have some skills such as imagination and creativity, critical thinking and problem solving, and communication, among others. For teachers to achieve that, their preparedness is of serious concern in utilising visuals in Physics if they are to pass them on to the students.*

Key Words: *Achievement, Effects, Graphics, Secondary School, Visuals.*

1. INTRODUCTION:

Physics, being a vital subject due to its numerous applications in human endeavour, is regarded as the foundation of all sciences, but many students struggle with it. As a subject, it has a high rate of failure. It is occasionally experiencing a lower performance rate than what learners' thirst for in the Kenya Certificate of Secondary Education (KCSE Analysis Merit List, 2019). Some students who struggle with Physics in senior high school, colleges, and universities drop or change courses because of their poor performance in the first year of the programme. Physics as a discipline requires students to develop a variety of understandings of methods as well as the ability to use Geometry, Algebra, and Trigonometry in building their process skills. Teachers and learners must understand the use of visuals in Physics. If both students and teachers use visuals, they will be able to better organise and plan. Scholars have debated the use of visuals or learning using a variety of representations or models. According to Shatri and Buza (2017), the use of visuals is an effective tool for increasing students' interest in and ability to comprehend word problems in mathematics. This is completely correct; it greatly improves students' thinking skills and prepares them to solve abstract concept problems not only in mathematics but also in science, particularly in Physics, which is considered difficult for students to understand. Torres and Mendes (2017) observe that due to a lack of connection with fundamental Physics theories, students struggle to visualise advanced Physics when studying mathematics. This is because they had not previously practised the mental connections of imagery in Physics that lead to some numerical computations such as graphs and other diagrams. The application of graphical representations of concepts in teaching and learning improves learner motivation and performance (Konyalioglu *et al.*, 2011). It assists students in developing critical thinking and analysis skills in Physics. After using models such as bars, charts, and graphs that explore students' experiences, they assist students in improving their conceptual knowledge of mathematical problem solving as well as their achievement in mathematical problem solving (Osman *et al*., 2018). This can help students solve Physics problems that require visual applications in order to improve their instructional objectives, particularly in practical problems such as laboratory problems that appear difficult to students. Bollen *et al*. (2017), on the other hand, claimed that learners had problems understanding, constructing, and switching between representations when using multiple representations. This is actually due to a lack of prior knowledge of representations in the initial stages of learning. According to Davis (2011), as cited in Moriyanti *et al*. (2019), children learn how to examine comprehensions through specific processing strategies that are aided by pictures or image analysis. According to Ranak (2016), one component that must be developed through models or visualising concepts is students' ability to generate critical thinking processes. This implies that the use of visuals is critical in the current CBC regime as teachers prepare students to engage in critical thinking. According to Frick and Newcombe (2015), when students see photos rather than drawings, their performance improves. That is not the case; when children see photos, they also practise drawing them, which encourages them to develop an interest in drawing or diagramming as they see and hear information during their learning process. Carden and Cline (2015) argued that if teachers want their students to have specific problem-solving strategies and methods in adulthood, they should begin training them in primary school. This will allow learners to transfer learning activities from the primary level to the next level, which is really essential for learning because learning can only occur when knowledge is transferred. However, students' challenges in solving Physics problems can be mitigated by having to teach them how to use visual representations that accurately describe real issue structures and the interconnection between solution-relevant components, known as visual schematic representations (Anton *et al*. 2016). In fact, visual schematic representation (V.S.R.) assists students in understanding problems and identifying calculation procedures, which significantly contributes to effective problem solving in Physics. It aids in the development of Physics formulas that are not directly stated in Physics and paves the way for identifying methods to be used for problem solving. Klein *et al*. (2018) realised that connecting mathematical ideas in Physics to visual representations is a difficult task for learners. As a result, the use of visuals is critical to the success of secondary school learners in the study of Physics. Yinka *et al*. (2019) argued in a study that multiple representations offer inspiring learning tools that foster learners' knowledge of Physics conceptions, and therefore, Physics cannot be learned without representations. It does not only enable them, but it also helps to motivate them whenever they see abstract concepts being concretized in order to beat their misconceptions.

The creation and use of graphical (animations, diagrams, and multimedia) representations of information is referred to as visual. In the teaching of Physics, it helps to concretize abstract concepts. Visual aids in data analysis and interpretation of scientific phenomena Visual in Physics integrates imagery-learning methods, as argued by Fahmy and Alkazemi (2017). It indicates that Students will have the opportunity to expand their process skills such as pictorial diagrams, graphs, graphics, observation, analysing experimental data, and recording as examples of visuals in the context of learning Physics. It aids students' achievement, particularly in laboratory or practical activities in which students visualise Physics theories and concepts to improve academic performance in Physics. It assists students in developing a favourable attitude towards the course. Bradley *et al.* (2019) posit that students in the United Arab Emirates (UAE) rely solely on information provided by their teachers during lectures. This method of teaching Physics without the use of visuals has a negative effect on students' learning and understanding of Physics because principles, laws, and theories cannot be understood and verified through lecture but must be verified through visuals. Image processing or visualisation improves students' understanding and learning performance in science, particularly Physics, which involves many experiments to verify laws, theories, and principles. The study was meant to determine how frequently visuals are utilised and the effects of visuals on learners' academic achievement in Physics in public Secondary schools in Thika, Kiambu County, Kenya.

2. LITERATURE REVIEW:

Frequent Utilization of Visuals in Teaching Physics

Despite numerous discussions concerning visuals in Physics education, how frequently are they used? Mathews *et al*. (2022) argued that using visuals to teach difficult concepts on a regular basis could enable students to comprehend them better. Students become more involved with learning materials when visual technologies and methods are used consistently in biology teaching (Barrow, 2022). Through active learning, these technologies and methods enable learners to engage with subject matter by constantly practising how to do them. According to Aridi and Saad (2020), learners are frequently encouraged to use an analytical method while working with tangible representations of phenomena to visualise activities, thereby increasing critical thinking and communication skills. Learners are more likely to retain important concepts and prevent unnecessary misunderstandings, resulting in representational fluidity. The process improves communication and critical thinking while also providing an analytical approach to a variety of problems learners encounter.

Effects of Visuals on Learners' Performance in Physics

The effects of visuals in learning, especially in physics, are determined not only by how well students learn when they are utilised but also by how frequently teachers and learners use them. It involves incorporating visualisation techniques and strategies into classroom instruction (Naps *et al*., 2003).Visuals in an educational setting enhance the achievement of objectives (ideas, scientific evidence, concepts, and so on). Without the use of visuals in teaching to facilitate perceptions of teaching materials and stimulate their better achievement by the student's audience, 21st century education is impossible (Bulyk & Kushniryk, 2020). Hartman *et al*. (2019) argued that since the advent of the internet, learners' preferences for learning have shifted dramatically. The invention of the internet has influenced students, and they no longer prefer the servile routing of information by teachers. This suggests that learners prefer to watch an activity being performed and actively try to recreate it instead of reading or being given instructions about a topic (Swanzen, 2018; Genota, 2018). As they try to imitate their teachers, the learning environment shifts from teacher-centred to student-centred. Nevertheless, with the inclusion of technology in today's learning, the use of visuals has created changes and opportunities for both teachers and students. Many of the teachers admit the advantages of incorporating new methods into their teaching, which include benefits placed above conventional methods of teaching and the ability to improve learners' outcomes in secondary schools, especially in physics. Instructional visuals positively affect students' understanding and knowledge, consciousness, recall, and solving problems, according to Warger (2018); they are an integral part of problem solving in physics, but several students have not utilised them. Instructors' inability to focus on visuals in teaching their students throughout their early learning process makes a significant contribution to students' low performance in Physics. Jones and Kelly (2015), on the other hand, argued that how students view and construe multiple kinds of molecular visuals, as well as the best methods to progress and then use static pictures and creative visual representations, are extremely crucial for chemistry learning. In this regard, learners should be able to use and analyse motion animations not just in chemistry but also in Physics, where learner performance and enrolment have been low, especially in Thika East, Kiambu County, Kenya.

As a result, students need to use visuals to make sense of the text by trying to picture it in their minds. Visuals encourage students to focus on the text they are reading (Musdizal, 2019). Students who read texts without visualising them in Physics are unable to think rationally, overcome, or accept the concretization of reality about abstract concepts. According to Santos and Arroio (2016), using visuals in chemistry can increase students' model precision and ability to comprehend chemical manifestations by epitomising ideas that words cannot describe in detail. In terms of science, visuals build learners' knowledge and understanding in a way that words or active voice cannot. Moreover, Sunyono *et al.* (2015) suggested in a study that using visuals, especially learning with multiple illustrations, is reasonable for lessons in which students with constrained or slow learning abilities are expected to keep up with those with medium and high learning abilities. This is the primary function of visuals in learning (Samuel, 2019), particularly in Physics, which has been identified as the most difficult or unfavourable area of study by secondary school learners and, subsequently, colleges and universities. Since the world is changing.

3. MATERIALS AND METHOD:

A descriptive survey was employed in the present study using the mixed method. The descriptive survey research method was suitable for this study since it captures current issues such as teachers and students' perceptions towards the utilisation of visuals in secondary schools' Physics teaching in Thika East. The methodology of descriptive survey studies concentrated on answering the how, what, when, and where concerns (Smith, 2021). Kothari (2009) claimed that the aim of descriptive survey methodology is to gather relevant information on aspects of teaching and learning areas that are of interest to researchers, policy experts, and curriculum designers. A descriptive study strives to fully reflect the characteristics of a specific situation. It is concerned with the perceptions, viewpoints, feelings, and perspectives of a study's chosen sample of the population (Akhtari, 2016). Self-developed questionnaires and a lesson observation checklist were used to collect data. The five-point Likert scale was used to measure the opinions of both teachers and learners. The instruments were piloted in two public secondary schools. The instruments were validated, and the reliability of the alpha Cronbach was.78, indicating the reliability of the questionnaires in the study. In this survey, stratified sampling was utilised to divide the eight public secondary schools in Thika East into county and sub-county schools. County schools are stratified as boys' schools, girls' schools, and mixed schools. The researcher selected this stratified sampling to reflect each stratum in the study and provide a complete picture of what is happening in Thika East. Mugenda and Mugenda (2019) point out that whenever the study population is heterogeneous, a stratified technique is required. As a result, the public secondary schools in Thika East are all different. The purposive sampling technique was particularly useful for teachers. The study aimed to use this type of sampling technique since a special population of teachers from Thika East was targeted for this study. Purposive sampling focuses directly on specific attributes or features of the participants that are of concern, allowing researchers to answer research questions more effectively (Andrade, 2021). Two hundred and ninety-four (294) Form Two learners were selected randomly.

Data Collection:

Before beginning data collection, the researcher was given a permit letter from the National Commission for Science, Technology, and Innovation (NACOSTI) and other further authorization letters from local governments to the schools that were part of the study and sought consent from the respondents. Finally, the researcher conducted lesson observation using the Reformed Teaching Observation Protocol (RTOP) for undergraduates in STEM. It focuses on how teachers and learners maximise their time in the science classroom (Smith *et al*., 2013).

Data Analysis:

The data collected was categorised, coded, and scrutinised using SPSS 20 (a statistical package for social science). Descriptive statistics were used for the analysis. Frequency, percentage, Pie charts, and bar graphs were used to display information. A total of five teachers' questionnaires and 294 questionnaires for Form Two Physics learners were distributed and collected at a 100% response rate.

Findings Regrinding Frequent Utilization of Visuals in Teaching Physics:

The researcher established how frequent visuals are used in the teaching of Physics in public secondary schools among Physics teachers**.** The findings are presented in Table 1.0

Table 1.0 Frequent Utilization of Visuals in Teaching Physics

Statements:	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
More than twenty percent of Physics class time should be devoted to using visuals.	20.0%	60.0%	0.0%	20.0%	0.0%
Less than twenty percent of Physics class time should be devoted to using visuals.	20.0%	20.0%	0.0%	60.0%	0.0%

The findings established that 60% of the teachers disagreed that more than twenty percent of Physics class time should be devoted to using visuals but also agreed that less than twenty percent of the class time should be devoted to using visuals. This implied that visuals are not frequently used. Frequent applications of visuals make it easier for Physics teachers to present hypotheses, analyse, and interpret data. The use of visuals assists Physics teachers in representing, analysing, and interpreting data. The findings of this study are consistent with an earlier study conducted by Smith and Cekiso (2020), who revealed that teachers' lack of visual skills hampered their use of visuals in the classroom on a daily basis. Teachers' lack of understanding and inadequate use of visuals for teaching Physics is concerning, as visuals play an important role in the process of concretizing abstract concepts in Physics. This suggests that teachers who have poor visual comprehension are less likely to use visuals on a daily basis.

Effects of Visuals on Learners' Academic Performance

Learners were asked about the effects of visuals on their academic performance in Physics. The findings showed that visuals have a positive effect on learners' academic performance if they are adequately utilised. Table 2.0 presents the findings as shown.

Table 2.0 Effects of Visuals on Learners' Academic Performance

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Whenever my teacher uses picture or diagram to teach, I remember the lesson well.	2.1%	4.8%	0.3%	47.8%	45.0%
The use of diagrams helps me to picture abstract concepts in Physics	6.9%	6.9%	5.5%	42.2%	38.4%

I learn more when teacher demonstrates and gives opportunity to students to investigate	5.5%	6.2%	2.1%	33.2%	52.9%
Using diagram or graph to solve questions makes the problem-solving in Physics easy and interesting	13.5%	14.5%	1.4%	35.3%	35.3%

The findings showed that 47.8% and 45.0% of the students agreed and strongly agreed, respectively, that they remembered their lessons very well when teachers used diagrams to teach. The findings also indicated that 42% and 38% of the learners agreed or strongly agreed that diagrams help them remember abstract concepts in Physics. However, 32.2% and 52.9% of the learners also agreed and strongly agreed, respectively, that when teachers demonstrate and give students the opportunity to investigate, they learn more. In using diagrams or graphs to solve equation-related problems in Physics, 35.3% of the learners agreed and strongly agreed that it makes problem solving in Physics easier and more interesting. From the analysis, the findings showed that there is a positive effect of visuals on learners' academic performance in secondary school Physics. The findings show that learners confirmed a positive perception of visuals and showed admiration for the role that visuals play in learning Physics. The majority of the learners agreed and strongly agreed that whenever teachers use pictures, videos, or diagrams to teach Physics, they remember the lesson very well. The findings of this study reverse the earlier study by Klein *et al.* (2018), who found that many students' admiration of models in Physics education has indeed been limited.

4. DISCUSSIONS :

Findings revealed that the majority of the Physics teachers in secondary schools agreed that this aids in concretizing abstract concepts. However, mostly Physics teachers strongly disagreed that more than twenty percent of Physics class time should be devoted to using visuals but also agreed that less than twenty percent of the class time should be devoted to using visuals in teaching. Teachers' overdependence on chalkboards to solve mathematically related problems has caused limited use of visuals at schools and a lack of skills to use available visuals. In these findings, it was observed that when teachers used visuals frequently to teach, learners created interest and became more engaged with and understanding of the lesson. It was also observed that teaching tasks become easier and more contents are covered when visuals complement teaching. The majority of the learners also agreed strongly that when visuals are used in teaching Physics, they remember the concepts. In using diagrams or graphs to solve equation-related problems in Physics, the majority of the learners strongly agreed that it makes problem solving in Physics easier and more interesting. From the analysis, the findings showed that there are positive effects of visuals on learners' academic performance in secondary school Physics.

5. CONCLUSIONS :

As established by the findings of the study, the researcher concludes that:

Visuals are vital in the study of Physics in secondary schools. Learners need perceptual stimulation to help them understand and retain abstract concepts in Physics. The frequent and effective use of visuals in teaching secondary schools Physics substitutes for boring classroom environments.

Learners build and expand their personal grasp of the subject matter when they have a successful and enjoyable learning experience in the classroom. Therefore, visual sessions are effective and relevant to learners when they directly relate to the course content. Moreover, because physics is a practical subject, more difficulties arise in conveying the knowledge to the learners. Therefore, Physics teachers need to frequently rely more on visuals to motivate learners, spark their interest, and encourage their participation in the lesson. Therefore, visuals are mostly used for classroom demonstrations to save time and cover more content.

6. RECOMMENDATIONS :

The study has pointed out that visuals are very important in the teaching and learning of Physics for learners' academic performance in secondary schools in Thika East, Kiambu County, Kenya. The study therefore recommends:

- The education system should allot time per topic for the use of visuals in teaching Physics.
- There is a need for the government and other authorities in education to provide periodic seminars for Physics teachers on using modern technological visuals in teaching Physics.

- Physics teachers should be encouraged to use as many visuals as possible to stimulate and make abstract concepts more concrete for conducive learning.
- The same study should be done in other sub-counties or counties in order to validate the reliability of the study's findings.

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