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Students' Attitudes towards computer-assisted learning in Biology subject in a selected secondary school in Uasin Gishu County, Kenya.

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Abstract
Background: *Any career in STEM discipline is shaped by the attitudes towards science education in secondary schools. In turn, attitudes are determined by teachers, environment and individual factors. The unsatisfactory performance in the national examination in Kenya in Biology, calls for a review of the student-related factors influencing achievements. On the other hand, the adoption of ICT in learning has been proven to have a positive impact on the student's attitudes, however, there is limited empirical evidence to support the use of ICT in teaching Biology classes in Kenya. Due to the dearth in studies within the local context, the study examined how Computer Assisted Learning (CAL) or Computer-Aided Instruction (CAI) can realign the student's attitudes towards Biology subject for form-four class in a selected secondary school in Uasin-Gishu County. The concept of mutations is taught under the topic of genetics and is abstracts as there are no laboratory experiments that can help the students to grasp the actual processes of mutations in cells.*
Materials and Methods*: This study designed a CAL lesson and measured student attitude towards learning mutations in the biology lesson using a Pretest-Posttest control group design to compare the computer-assisted learning with conventional teaching methods. The study used the experimental design to compare the differences between the experimental and the control group from a total of 54 students from Kerotet Girls High School in Uasin-Gishu County, randomly sampled and equally placed into the groups. First, the study measured the attitudes towards biology using a conventional tool before assigning them into the groups. The experimental group used the CAL, while the control group used the conventional methods (lecture and discussion). The experiment was spread over five lessons lasting one hour totalling 300 minutes. The achievement and attitudinal components were assessed by the Biology Achievement Test (BAT) and Student Attitude Questionnaire (SAQ) respectively. The data generated were entered into statistical software and analyzed using descriptive and inferential statistics. Importantly, Importantly, χ^2 was conducted at ά = 0.05 significances level of significance.*
Results*: At the onset, there were no significant differences in the students' attitudes with χ^2 ranging from 3.933 to 7.522($p > 0.5$) between both groups but at the end, there were changes in attitudes towards biology with higher positive attitudes towards the use of ICT in biology subject. The achievement scores for the experimental group was statistically and significantly different ($t = 10.89$, $p < 0.05$) from the control group. Thus, the students exposed to the CAL lesson show higher positive mental attitudes and performed significantly better on the BAT. However, the finding must be interpreted with caution in light of sample size.*
Conclusion: *The computer-assisted learning module influences student's attitudes and can be considered as an efficient instruction medium for aligning students' attitudes in secondary schools in Kenya. The study recommends that the schools explore several techniques and means that include CAL to grow and sustain students' attitudes towards biology subject and STEM discipline as a whole.*
Keywords: *Computer-assisted Instruction; computer-assisted education; computer-assisted learning; computational attitudes; learning styles.*

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I. Introduction

The interest in school science and technology links achievement and the intentions to pursue studies or careers in science and technology subjects (Potvin & Hasni, 2014a). The linkages between interest and attitudes towards science and mathematics education determine the career choices in STEM (science, technology, engineering, and mathematics) discipline. Furthermore, attitudes have more impact than enrolment or achievement figures (Maltese & Tai, 2011) and serve as important learning goals in science education (Tekbiyik

& Akdeniz, 2010). Guy, Cornick and Beckford (2015) and Villavicencio and Bernardo (2013) reported that student's affective characteristics significantly influenced learning and achievement in science subjects.

Extant literature has shown that the association between interest, motivation and attitudes and achievement on science and mathematics tend to decline during the school years (Sjøberg & Schreiner, 2010). Empirical evidence has shown significant decline in the attitudes towards science subjects in several countries including the UK, where a study revealed that the learner's interest and attitude to science decline at the point of entry to high school (Potvin & Hasni, 2014a).

This drop-in interest, motivation and attitudes occur between elementary and secondary school (Potvin & Hasni, 2014) and as reported by Barmby, Kind and Jones (2008), the variances in attitudes in England indicate that student's attitudes towards science declined as they progressed through secondary school and that the decline was more pronounced in female pupils. Studies have attributed the decline to the basic schooling systems which does not preserve the initial strength of students' attitudes for science and technologies. Further, the current school science may be considered "unattractive" by the students as it does not involve topics of interest or provide students with opportunities for creative expression (Christidou, 2011). Sometimes, the attitudes might wane or are held back by their perception towards school science (Savelsbergh *et al.*, 2016).

Other reasons for the decline include the science curricula, school textbooks, teachers, teaching techniques which negatively affect students' attitudes and interest (Christidou, 2011). Sometimes, this decline relates to structural and infrastructural challenges facing the schools which include; the costs involved, time consumed and inaccurate data sets during the laboratory procedures. Other challenges include the nature of practical work in science education which do not help learners develop procedural knowledge (La Velle, McFarlane & Brawn, 2003). It may also mean that the fragmentation of the science education into strictly isolated and distinct disciplines presented in contexts may deter the student's interest by failing to provide a coherent picture of the discipline (Christidou, 2011) or the deficiency in teaching skills influences the knowledge acquisition (Schittek *et al.*, 2001).

A study by Christidou (2011) affirmed that students rapidly lose their interest in science and cease seeing it as a viable option for their future, or associating it with their success aspirations. This has seen the largest decline in attitudes towards learning science in schools (Barmby *et al.*, 2008). The attitudinal aspect of learning tends to vary by topic and by gender, however, a similar general trend exists for mathematics and most of the sciences, with the decline occurring in most countries that have attained certain output levels (Schreiner & Sjøberg, 2010). However, critics have voiced concerns with the attitudinal – oriented approach saying that the emphasis on affective outcomes which include attitude, interest and motivation might come at a cost of achievement outcomes. But the affective outcomes are important in the long run (Savelsbergh *et al.*, 2016).

To begin with, attitude is to be defined as the feelings that an individual has about an object, based on his or her knowledge and belief about that object. This definition is based on the inclusion of three components of cognition, affect and behaviour (Barmby *et al.*, 2008; Potvin & Hasni, 2014) with the corresponding positive or negative (like or dislike) inclinations toward an object (Potvin & Hasni, 2014). This definition encompasses short-term situational interest (state) as well as long-term personal interest (disposition) (Savelsbergh *et al.*, 2016). The interest is more of the psychological state of engaging or the predisposition to reengage with particular classes of objects, events, or ideas over time (Savelsbergh *et al.*, 2016). Therefore, knowing the attitudes and interest would then explain the differences in achievement outcomes among students and the steps taken to address the issue.

Science teachers play a crucial role in the formation and reorganization of students' conceptions and attitudes towards science. Hence, the teachers' perceptions and attitudes towards science influence the students' attitudes. Previous studies have shown that teachers with a positive view tend to draw a commensurate positive opinion among students (Christidou, 2011; Potvin & Hasni, 2014). Further, the positive attitudes towards science and technology serve as important learning goals in science education (Sjøberg & Schreiner, 2010).

Due to the proximity of the teachers to the students, several teaching and learning techniques have been advanced as a way of improving the overall students' attitudes and achievement in science education (Sjoberg & Schreiner, 2010; Savelsbergh *et al.*, 2016). In particular, the integration of computer technology in education is gaining popularity by providing a learner centred-atmosphere environment, creating interest and helping increase the students' motivation. Other advantages include; the promotion of active learning environments, the development of problem – solving and knowledge construction and discovery (Serin, 2011), intrinsic motivation and engagement experience for the learners and increases learner's effort in the subject areas (Mo *et al.*, 2015)

Technology is not only a medium but a cognitive partner that amplifies or augments students learning (Jang & Tsai, 2013) and has dramatically changed the environments and processes by which students learn and communicate, altered the design and administration of instruction and assessments (Shute & Rahimi, 2017). In Europe, the use of ICT in secondary school education is considered a key factor in improving quality at this educational level as it provides avenues for a rethink and redesigns of the educational systems and processes

(Sangrà & González-Sanmamed, 2010). However, effective use of ICT is contingent upon the established pedagogical practices and the application of ICT within them (La Velle *et al.,* 2003).

ICT provides a more effective method of developing both substantive and syntactic scientific understanding, its usage in science is powerfully in exploration, development, expression and critically, and redrafted ideas and concepts (La Velle *et al.,* 2003). In particular, computing technologies such as CAL/CAI are used as knowledge construction tools by students (Hwang, Shi & Chu, 2011). CAL has been existence for several decades but its broader adoption and application was made possible by the advent of personal computers (Županec, Miljanović & Pribićević, 2013) and as an instructional technology, it become an essential trend in educational processes (Jang & Tsai, 2013). CAL facilitates learning and is alternative learning assistance with different concepts, approaches, contents and target users (Ahmad & Abdul Mutalib 2015).

CAL is visually attractive through demonstrations by animation, colour and sound (Županec *et al.,* 2013). CAL is versatile in the classroom in that learning principles and methodological implications remain identical, as long as the interaction remains between the user and the content (Schittek *et al.,* 2001). It is an effective strategy for teaching both the theory and practice in discipline ranging from education to medicine (Bloomfield, Roberts & While, 2010), its usage in science education enhances students′ scientific investigations and reasoning and connects constructed knowledge to practical work (Jang & Tsai, 2013).

The attainment of scientific attitudes is an equally important goal for science education [25] and therefore several intervention studies have established that several teaching approaches such as inquiry-based, collaborative work, integrated ICT usage have a modest positive effect on attitude/motivation/ interest (Savelsbergh *et al.,* 2016; Potvin & Hasni, 2014b). The integration of ICT into teaching has been postulated to lead to more positive attitudes usage gains based on the mechanisms that include students enjoying working with computers, students feel safer to experiment and make mistakes, and/or students appreciate the (quick) feedback (Potvin & Hasni, 2014b). Several authors have asserted that the communicative opportunities in computing technologies may promote positive attitudes towards a collaborative and constructive learning perspective (Sangrà & González-Sanmamed, 2010), while enhancing students′ interests in learning strategies (Jang & Tsai, 2013). Computer-assisted learning environments also aids in learning and are motivational tools (Huang, Liu & Chang, 2012).

Several studies showed that CAI was more effective than the other methods in increasing students' interest in science lessons (Tekbiyik & Akdeniz, 2010). Linden, Banerjee and Duflo (2003) affirmed that agood and well-designed educational software can sustain interest and curiosity even in an otherwise dull school environment. Usage of CAL changes students' attitudes and motivation for learning, for instance in biology lessons, students can use various technological tools, thus indicating clear evidence of increased enjoyment and interest (La Velle *et al.,* 2003). In the primary level of education many pupils demonstrate a vivid interest in science and mathematics (Savelsbergh *et al.,* 2016), however, their attitudes decline in the middle grades (Potvin & Hasni, 2014a).

Empirical evidence suggests that interest, motivation and attitudes and performance including its associated perception usually appear to go hand-in-hand (Potvin & Hasni, 2014).CAL influences the attitudes (Morgil *et al.,* 2005) sustain the interest and curiosity of students and can lead to higher achievement gains (Mo *et al.,* 2015). This was validated by a study on the upper elementary school in Spain which indicated that positive attitudes explained 21.3% of the variance in mathematics achievement (García *et al.,* 2016). However, empirical evidence in Israel and the United States showed that little consistent evidence as to whether the application of computer technology has beneficial effects on math and reading test scores (Mo *et al.,* 2015).

Table 1: National Mean Grade for Biology Subject in Kenya

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mean	54.29	58.39	64.87	52.41	63.26	63.65	69.59	58.37	37.85	51.38	51.28
SD	28.80	30.44	31.05	29.43	32.06	32.57	31.55	35.16	23.45	23.26	23.27

Source: KNEC reports

Table 1 shows that the performance in Biology subject has not been satisfactory and as indicated the average scores for the last four years are 58.37, 37.85, 51.38 and 52.32 marks (KNEC, 2019). This shows the average pass mark for all the students taking biology as a subject in secondary schools in Kenya is just above average. The report by the Standard media group reported that the performance in the Biology subject has been on a downward trend for the last three consecutive years with only a small number of students getting grade B and above. The trend is raising concerns that many bright students will be locked out of studying science courses (Standard Media, 2019). Because of the significance of Biology as a subject in the STEM discipline, there is a need for improvements in techniques for teaching mathematics and science education (Maltese & Tai, 2011).

Several researchers have proposed that affective learning outcomes might be more important to further learn than cognitive ones, but then empirical surveys have observed a weaker link between attitude and achievement (Maltese & Tai, 2011). Furthermore, the literature on science education at the basic level has covered several intervention mechanisms designed to change attitudes, whose effect sizes are marginal. Some of the challenges affecting the result include the differences in the curricula content in a different context, nevertheless, several reviews and studies have documented the effects of innovative teaching approaches on attitude and/or achievement. The impact on achievement have been synthesized, but a systematic overview of attitude effects is missing in the developing country context (Serin, 2011).

The empirical evidence on the impact of computer-assisted learning (CAL) to improve learning outcomes is mixed (Mo *et al.,* 2015). Computer-assisted learning (CAL) is considered is an alternative to effectively improve learning outcomes, but the empirical evidence examining its effectiveness is mixed (Lai *et al.,* 2013). Several educational innovations such as integrated ICT usage among others have been proposed, both in science and mathematics education to foster positive attitudes, but there is little systematic evidence about which educational approaches are effective to promote interest, attitude, and motivation (Fortus, 2014).

The impact on achievement have been synthesized, but a systematic overview of attitude effects is missing (Savelsbergh *et al.,* 2016). Further, empirical research in high school educational stages in Sub-Saharan Africa remains scarce. Studies that have explored the influence of affective emotions have been conducted in young and small samples and described these components as an indeterminate set of predispositions such as persistence, emotion regulation, or attentiveness (García *et al.,* 2016). As elaborated by the preceding reviews, there is a need for a holistic evaluation of interest and attitudes towards science and mathematics at the high or secondary school level. Therefore, the study examined how the integration of the CAL in teaching secondary schools influences the attitudinal component of the students in Uasin Gishu County, Kenya.

II. Method

Aims

The primary aim of the study was to evaluate the effects of a CAL module on attitudes towards biology as compared with conventional face-to-face classroom teaching in a selected secondary school in Uasin Gishu County, Kenya. The null hypotheses for the study were:

1. There is no significant difference in student's attitude towards Biology when taught using the CAL approach and when taught using conventional approaches.
2. There is no significant relationship between the students' attitude towards Biology and concept mastery.

Participants

The study was carried out in Kerotet Girls high school, Uasin Gishu County, Kenya with 154 form-four students. The study used 35% (54 students) who were split into three homogenous sets based on their intellectual abilities of 'below average, 'average' and 'above average'. The grouping was based on the average mark for Biology subject in the last three school terms; second and third term of form-three and the first term of form-four. Since previous studies have used varied sample sizes, no formal sample size calculation was not undertaken, but strenuous efforts were made to ensure that the most appropriate sample size was used. From the homogenous clusters, twenty-two (22) students whose average scores were below 50% were placed in the 'below average' and out of which seven students were randomly selected for the enrolment into the experiment. Next, the eighty- two (82) students who had an average score of between 50 and 60% were placed in the 'average' and from which 29 students were randomly enrolled into the study. Lastly, fifty (50) students who had an average score of over 60% were placed 'above average' category and from these, 18 students were enrolled in the experiment.

The fifty-four (54) students enrolled on the experiment were split into either the experimental and control group. This was achieved by sequentially allocating a unique code to the student participants, after which a computerised random number generator assigned the participants to the intervention (CAL) or control (conventional teaching method) group using the unique codes. The two groups were then taught separately, with the experimental group using CAL while the control group was taught using the conventional methods. The concept of mutation in the experimental group was taught outside the normal class hours (5.00 pm-6.00 pm) in the computer laboratory while the control group was taught with the other students who had not been chosen for the study in their respective classes.

Design

The study used the experimental design known as the Pre-test – Post-test Control Group design which involved two assessments at the onset(pre-test) and the end(post-test) with the use of control groups. A student attitudinal test (SAT) was handed to both groups to gauge their attitudes towards biology, after which a Biology Achievement Test (BAT) pre-test was administered to both groups. Data were collected at three time points during the study between May 2018 and July 2018. Baseline data, generated from a student attitude questionnaire and biology achievement test, were collected from all participants immediately before the teaching intervention. The groups were assessed based on the biology achievement test (BAT) at the end of the experiment.

Teaching Intervention

The two teaching methods were compared and both approaches were expected to take one hour daily for a period of five days or 300 minutes duration and were designed to facilitate the acquisition of concepts of mutation.

Conventional module

The participants in the control group (n = 27) were taught in a normal classroom setting. This involved the preparation of a lesson plan using the standardised teaching pack: a secondary school biology curriculum; a set of secondary school biology, shorthand notes on mutation, chalks and blackboard. Short notes explaining each type of mutation were prepared using various textbooks; secondary school biology book four by Kenya literature bureau, longhorn biology book four, comprehensive biology book four and principles of biology volume two. All the illustrations were done on the board and the books and any questions about the subject matter were answered by the researcher who was also a science teacher in the school.

The whole concept of mutations was taught for five lessons each lasting for one hour daily over a period of five days (300 minutes). Ideally, the biology lesson is always allocated seven lessons in the syllabus and each lesson takes 40 minutes. In total the whole concept is covered in 280 minutes. The evaluation questions at the end of each lesson were also prepared using the same textbooks. The researcher tried as much as possible to operate within the time allocated

CAL module

The experimental group (n = 27) were taught using a specific computer-assisted learning/instruction (CAL/CAI) module. The CAL lesson was developed in line with the objectives outlined in the Kenya National Examination Council (KNEC) syllabus. The participants in the experimental group were knowledgeable in computing technology and complete the study under the instruction of the researcher. The content for the lesson was videos and animation on mutations downloaded from the internet and loaded into all the personal computers in the computer lab.

The CAL lesson consisted of five (5) lessons taught over a period of one week. Each lesson lasted for one hour over the five days making up a total of 300 minutes. The CAL lessons comprised animations, computer illustrations and brief explanations. After going through the lesson, the students discussed what they had learnt in groups of two and made brief notes. There were evaluation questions at the end of each lesson that the students answered and handed over for marking.

The researcher always secured the computers with the password and unlocked the computers during the lesson time. This ensured that no student accessed the lesson in the absence of the teacher and that the control group did not access the information in the computer because both experimental and control groups were in the same school. At the onset of the lesson, the research provided an outline of the activities for each lesson each day before unlocking the computers for students to learn.

Outcome measures

The study had two measures; the attitudinal measures to evaluate attitudinal changes and the achievement scores to assess the achievement outcomes. The researchers used two instruments that provided high accuracy, generalizability and explanatory power, with low cost, rapid speed and maximum management demands and administrative convenience. The instruments included the Student attitude questionnaire (SAQ) and Biology achievement tests (BAT).

Attitudinal aspects

In seeking to assess any of the affective outcomes in the basic education system, there is the need to capture both transient and the permanent aspects of the affective outcomes at any one moment as they form the core affective emotion in different context and curricula. Use of conventional constructs or fine-grained frameworks may suffice but the simpler and effective way is to generate simple and easy to understand constructs. The application of specific constructs allows for highly specific conclusions but limits the opportunities to compare outcomes across a wider sample of studies [25].

Based on the foregoing literature, a baseline student attitudinal test was purposefully developed and consisted of questions on an agreement continuum ('Strongly disagree' 'Strongly agree'). This test consisted of six – questions with a five-point Likert type scale that evaluated the students based on the statement's levels of agreement/disagreements (strongly agree, agree, indecisive, disagree, and strongly disagree).

Achievement scores

The achievement outcomes were based on a biology assessment test (BAT) and comprised of standard questions examinable in the earlier national examinations and were marked out of 50 marks. The tests assessed the student's ability to comprehend, analyze and synthesize information and were given to the participants before and after the experiment.

Analysis

The data analysis was based on a pre-established analysis plan using the SPSS (version 20) statistical software package to carry out both the descriptive and inferential statistics. The statistical tests of a non - parametric and parametric nature were employed at 0.05 conventional significance levels. The χ^2 analysis tested for any significant differences between the two study groups, while the t-test checked for statistically significant differences in the BAT test scores between the groups at each phase of the study.

III. Findings

Biology Attitudinal change

Table 2 Descriptive statistics for pre-test scores

	Control			Experimental			Statistics	
Variable item	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	χ^2	**p**
Biology is a boring subject	27	1.22	0.424	**25**	1.36	0.490	3.900	0.420
I like biology very much	27	4.63	0.688	**25**	4.56	0.712	5.144	0.273
Biology is an interesting subject	27	4.67	0.480	**25**	4.64	0.490	5.487	0.241
I look forward to biology class	27	4.56	0.506	**25**	4.36	0.952	7.522	0.111
I only understandbiology during class time	27	2.41	0.844	**25**	2.04	1.020	5.583	0.232
I will drop biology now	27	1.26	0.813	**25**	1.12	0.332	3.993	0.407

Table 2 shows the attitudinal aspects of the participants during the pre-test period. Regarding biology as a subject, the respondents strongly affirmed that they liked biology and never found biology to be boring.Biology is considered an interesting subject and the majority of the participants look forward to biology lessons. The participants were indifferent to learning biology as a subject with or without a teacher and this showed that they understand some biology concepts and would not drop biology as a subject.

The statistics in Table 2 examined for any association between the study variables and gender using the chi-square distribution. The statistic, χ^2 ranged between 3.900 and 7.522 with $p > 0.05$ indicating that there were no significant differences in attitudes of both experimental and control group participants. It can be inferred to mean that participants have a positive attitude towards biology thus any significant difference in achievement scores cannot be linked to their attitudes.

Table 3 Descriptive statistics for attitudinal scores on Biology subject

		Experimental group	
Variable item	χ^2	**Mean**	**SD**
Biology lessons using computers are difficult	27	2.33	0.961
Biology lesson using computers are interesting	27	4.44	0.506
Biology lesson using computers is a waste of time	27	1.15	0.362
Biology lesson using computers are clear	27	4.37	0.492
I understand the concept of mutation taught through computers	27	4.04	0.706
I like the biology lessons taught through computers	27	3.48	0.893
I can study biology lessons alone	27	3.52	1.252

Table 2 illustrates the attitudinal aspects of the experimental group towards the biology subjects after the experiment. The statistics show that majority of the respondents found biology lessons to be interesting, simpler, clear and understandable. Further, the use of computers – based instruction in the biology lesson saves times and allowed for self – regulated learning. The higher mean scores > 4.00 indicated that favourable outcomes towards the subjects of interest and thus could be construed to illustrate positive attitudes towards the Biology subject. On the negated statements, the mean score values < 2.50 showed that the participants held positive attitudes toward Biology lessons.

Biology Achievement Test Scores

Table 2 Comparison of biology test scores between study groups

	Control group					Statistics	Experimental group				Statistics
	N	Mean	SD	Min	Max	t-test	Mean	SD	Min	Max	t-test
Pre-test	27	31.30	5.377	20	46	t = 2.36	32.22	4.677	25	44	t = 10.89
Post-test	27	33.44	5.611	19	43	p =0.134	42.07	3.362	35	49	p = 0.016

The results as summarised in Table 2 shows the scores from the participants who completed the baseline BAT test. The pre-test scores for the control group ranged between 20 and 46 with a mean of 31.30 and a standard deviation of 5.377 while those for the experimental group ranged between 25 and 44 and had a mean of 32.22 and a standard deviation of 4.677. When these scores were compared between the study groups, no significant differences emerged between the groups in the pre-test scores ($t = 2.36$, $p > 0.05$). Significantly higher scores were achieved at the immediate follow-up with the scores for the experimental group ranged between 35 and 49 with a mean of 42.07 and a standard deviation of 3.362 while the scores of the control group ranged between 19 and 43 with a mean of 33.44 and a standard deviation of 5.611. there were significant differences between the scores of the groups ($t = 10.89$, $p < 0.05$).

IV. Discussion

The objective of the study was to examine whether CAL influences students' attitudes towards biology subject and whether CAL affects knowledge acquisition and mastery of the biology subject by secondary school students in Kenya. The findings support the integration of the CAL module as an alternative instructional technique when compared to the conventional teaching methods. The empirical evidence indicates that there were significant changes in the students' attitudes toward biology subject and this is supported by finding from several empirical studies which show CAL sustain the interest and curiosity of students (Mo *et al.*, 2015) and is connected to the perception change which is linked to motivation to learn and practice learning science education (Kajamies, Vauras & Kinnunen, 2010).CAI as a technique is reported to be more effective in increasing students' interest in science lessons (Tekbiyik & Akdeniz, 2010).

Empirical support showed that integrated ICT usage has a modest positive effect on attitude/motivation/ interest (Potvin & Hasni, 2014b) and that the arousal of interest and curiosity and changes in perceptions has been positively linked to the attitudinal changes (Morgil *et al.*, 2005; Hwang *et al.*, 2011; Pilli & Aksu, 2013). Evidence also highlights the concurrent effect of the teacher's attitudes positively influencing student's attitudes towards science education (Christidou, 2011; Potvin & Hasni, 2014) and this serves as important learning goal in science education (Sjøberg & Schreiner, 2010). Furthermore, a positive attitude is also linked to increases in self-regulated learning (Guy *et al.*, 2015).

High levels of positive emotion are associated with gains in the outcomes (Guy *et al.*, 2015). Further support for the findings from the studies that have linked attitudes and interest to achievement outcomes (Christidou, 2011; Mo *et al.*, 2015), with Potvin and Hasni (2014) reporting that perception, interest, motivation and attitudes and performance go hand-in-hand. The use of CAL is reported to induce faster learning, effective knowledge acquisition, mastery and retention and is efficient (Yusuf & Afolabi, 2010; Pilli & Aksu, 2013) while being effective in terms of quality, durability and applicability of knowledge (Županec *et al.*, 2013).

Lastly, CAL also simplifies pedagogy thus its effective usage as a meaningful learning technique has some positive effects on students (Hwang *et al.*, 2011; Serin, 2011) in that students using CAL/CAI have better learning outcomes (Morgil *et al.*, 2005; Tareef, 2014; Kumari, 2018). CAL increases the overall learner's achievement level with a commensurate higher performance level than the traditional teaching method (Županec *et al.*, 2013, Mo *et al.*, 2015, Potvin & Hasni, 2014). However, other studies indicate that the adoption and usage of computing technologies have varying outcomes because of the differences in education systems in countries (Mo *et al.*, 2015).

These findings suggest students are gaining cognitively from the use of CAL as an instruction medium and thus there is consequent retention and mastery of knowledge in the biology concepts, thus, the study participants can learn the theoretical abstracts faster. The achievement score was relatively high with a mean of 42 may be attributable to the significantly higher knowledge capabilities in all the three cognitive domains of knowledge, comprehension and application. Empirical support for the finding is drawn from Županec *et al.*, (2013) whose findings indicated that pupils taught with the CAL program achieved significantly higher quantity and quality of knowledge in all three cognitive domains of knowing, applying, and reasoning.

Lastly, the effectiveness of the CAL relates to the effectiveness in the presentation of information, testing and evaluation and providing feedback to the learner (Tareef, 2014). During learning, learners integrate new information with prior knowledge, organize new information, relate ideas, and regulate their understanding of the information which translates to higher academic performance (García *et al.*, 2016). CAL minimizes rote learning, thus encouraging meaningful learning (Županec *et al.*, 2013). CAL has been proven to be more efficient than the traditional methods in increasing academic achievement of learners in biology subject lessons: digestion and excretion systems, floral plants, reproduction of plants and animals among other topics (Županec *et al.*, 2013).

V. Conclusion

The generation of positive attitudes towards Biology subject among secondary school students represents a critical learning process, that consequently improves the mastery and retention of biological concepts. Thus, any innovative teaching strategy having positive effects on the students' attitudes should be evaluated for its effectiveness and validated by research. The study has valuable findings as confirmed by previous research which indicated that CAL positively influences attitudes and perception more than conventional teaching methods. Given the increasing use of e-learning, the findings provide credible evidence that CAL is as effective in influencing attitudes and students' achievement in secondary schools. Computer-based instruction/learning is a potentially valuable learning tool, that may be applied in several contexts that include self-study and distance education.

Limitation

The study was limited by the lower sample size and this affects the generalization over larger populations. The use of small sample sizes has the potential to introduce bias and therefore, findings from this study must be interpreted with caution. Any future research should be based on a larger sample size within the same context or locality. Despite this limitation, the strength of this study lies in the use of a rigorous trial design that addressed many of the flaws evident in previous research.

Contribution

The study contributes to the examination of attitudinal changes arising from the use of the CAL/CAI in science education in a secondary school setting in Sub – Saharan Africa and thus it provides a foundation for further studies to explore the concept.

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