Available online at: http://journals.rsfpress.com/index.php/ijrse
International Journal of Research in STEM Education (IJRSE)
ISSN 2721-2904 (online)
Volume 2 Number 2 (2020): 134-142

Computer Assisted Learning For Enhancing Mastery Of Concepts In Science

Sharon Anyango Onditi, Stephen Oloo Ajwang
Rongo University, Kenya

ABSTRACT

This study examined the effects of Computer Assisted Learning (CAL) on the mastery of Science concepts by learners in universities. Teaching and learning of Science concepts present learners with numerous challenges. Of critical concern is the negative perception by learners that Science based subjects are difficult, thus contributing to widespread poor performance by the learners in the national examinations and subsequently poor choice of the subject in the universities. Solomon Four Group experimental design was employed for the study. The target population comprised all first-year students taking science subjects in 8 universities in western Kenya. A sample size of 335 students was determined using Krejcie & Morgan table (1970). The universities were divided into two forming experimental and control groups. The study was carried out in 4 months spanning 16 weeks where pretest was administered after the first 8 weeks of conventional teaching and post-test administered after the next 8 weeks of treatment. Pretest and post-test Science Achievements Test (SAT) on two topics, digestive system and light and optics, were designed and administered by the respective lecturers, and scores recorded. Piloting was carried before the use of the instruments, and a reliability coefficient of 0.85 on SAT was recorded. Data were analyzed using t-test one-way ANOVA. The study found that 171 students taught using CAL achieved significantly higher scores in SAT compared to164 students taught through conventional methods with a mean gain of 2.851. The study demonstrated that CAL enhanced active manipulation of content and promoted interaction with content, and gave reality to abstraction. The study may be significant to educationists, lecturers, researchers, and policy makers as it provides insight on the benefits of applying Computer Assisted Learning in Science Education.

Keywords: *Computer-Assisted Learning, Learners, Achievement Test, Science Concepts, Universities.*

INTRODUCTION

Performance of learners in Science

The performance of learners in Science-based subjects in national examinations has largely remained poor compared to other subjects (Buindi 2013). Reports by Organization for Economic Cooperation and Development (OECD) indicated that 21% of learners across its member countries do not reach the baseline proficiency level of 2, which is the level at which learners should have acquired knowledge of basic Science content and procedures (OECD 2016). In Uganda, a study conducted by Black, Atwaru-Okello, Kiwanuka, Serwadda, Birabi, Malinga, Biumigishu, & Rodd (1998) showed that Science was a burden to the country's education system because of lack of practical experiences and teaching facilities. Similar studies in Tanzania have also indicated poor performance in Sciences (Hamilton, Mahera, Mateng'e & Machumu, 2010).

In Kenya, data from the Kenya National Examination Council (KNEC), not only shows a similar trend to the other East African countries but further reveals a steady drop in achievement in Sciences over the years (Business Daily, 2019). This has affected learners choice of Science subjects in secondary

Corresponding author
shahanyango@yahoo.com; oloohs@gmail.com
DOI: https://doi.org/10.31098/ijrse.v2i2.382

schools (Omondi, 2013; Maltese & Tai, 2011) and led to poor performances recorded in Kenya Secondary School Education (KCSE) examinations with Chemistry generating a mean of between 22.71 to 27.93, Biology 26.21 to 30.32 and Physics 31.31 to 37.86 between 2013-2017 (KNEC, 2017). The failure in the national examination has further resulted in the poor choice of science subjects for advanced studies in universities. This is because basic and secondary school Science provides the requisite background for the advanced studies of science in universities (Oduol, 2018). Poor performance in the Sciences is largely attributed to negative attitudes towards the subject (Omondi, 2013; Olatunde, 2009; Abudu & Gbadamosi, 2014), lack of teaching and learning materials (CEMASTEA 2017), poor teaching methods (Majo, 2016), and the difficulties in comprehension and understanding of Science concepts by learners.

The long term effect posed by these challenges is a reduced number of learners pursuing Science related careers, despite the fact that Science is considered as an enabler and foundation for wealth creation and economic development across the world (UNESCO, 2005; Muzah, 2011; Kibet, Mbugua, Muthaa & Nkonke, 2012)

Computer Assisted Learning

Due to the rapid rise in development and advancement in information and communication technology (ICT), the adoption and use of computers in the advancement of education cannot be ignored. Accordingly, there has been increased uptake and integration of educational technologies such as animation, audio-visual, simulation, and use of PowerPoint presentations in classrooms to help overcome teaching challenges and improve learning processes (Jesuraja, 2015). These technologies potentially enhance learner's academic outcomes by creating a richer environment for open and positive interaction and intuitive content delivery for better engagement and content retention by learners. Technologically, an innovative lesson is a proven gamechanger that could revitalize the education sector by promoting active learning (Bond & Bedenlier, 2019; Ainley & Engers, 2007). In addition, the use of technology has been argued, creates interest, and increases the learners' motivation, hence playing an important role in the teaching and learning process (U.S. Department of Education, 2017)

Due to the dynamism and advancement in learner environments, there is a need for universities to continuously adopt new pedagogical approaches for sustained engagement in order to influence learner behaviours, create a sense of ownership in the learning process, stimulate their intelligence, motivate and encourage them along the academic journey (Mynbayeva, Sadvakassova & Akshalova, 2017).

Because of the increasingly poor performance in Science, several studies have been carried out to encourage the use of CAL approach to enhance learners' grasp of Science concepts from formative to later school years. For instance, a study by Galang & Galang (2017) in computer-aided tool in Science for kindergarten pupils found that CAL was effective in enhancing learning in Science and allowed the kindergarten pupils to develop the foundation necessary for future academic success. In a different study by Bayrak & Bayram (2010), computer-assisted learning had a positive effect on the academic achievement of learners in Science and technology subjects. Tareef (2014), in his study on the effects of CAL on achievement and problem-solving skills of educational statistics, learners revealed that CAL was more effective on the learners' achievements than the traditional instruction methods. A study by Sharma, (2017) concluded that CAL has the potential to transform the education process and improve the efficiency of learning by encouraging and motivating learners. Taken together, these studies validate findings that prove that using CAL is an effective teaching method that can stimulate learner engagement and that engaged learners are good learners (Bryson & Hand, 2007; Jang, 2008; Troisi, 2014).

Appropriate use of CAL in teaching and learning Science can be beneficial to the acquisition of scientific knowledge and its practical application (UNESCO, 2012). The use of CAL has the potential to

ISSN 2721-2904 (online)

meet the requirements of a constructivist framework that can help learners to build and acquire knowledge and make sense of it (Ben-Ari, 2001).

The computer, as a learning tool, engages learners in interactions that build a more complete and richer recognition, recall, reconstructive, constructive, and intuitive understanding of concepts (Sharma, 2017). By so doing, CAL enables learners to internalize their thinking, perception, problem-solving, innovativeness, and manipulation of models provided by the computing system. CAL can also contribute to the acquisition of varied knowledge as well as to promote learner independence, peer learning, and the urge for schoolwork (Fafchamps & Mo, 2018). Further, CAL can enhance the lecturer's ability to hold each learner's attention and interest in the lessons, especially in large classes (Galang & Galang 2017). Besides, many learners are today exposed to at least a digital device at an early age thus have acquired to some degree skills to take up CAL with ease.

Because of the many benefits of CAL in Science teaching, researchers have championed its application to enrich learners' understanding of complicated concepts of Science (Keengwe & Onchwari, 2008). For instance, in CAL approach, simulation and gamification can be used to provide an environment or aspect of reality that is otherwise not possible to explore within the confines of the classroom (Dina & Ciornei, 2012; Sahin, 2006); teach concepts that are either difficult or dangerous (Hennessy, Wishart, Whitelock, Deaney, Brawn, Velle, McFarlane, Ruthven & Winterbottom, 2007). Use of interactive computer animation to model complex realities in the understanding of cells in Science (Cakiroglu & Yilmaz, 2017).

The rationale for the study

Despite the above benefits, limited empirical data exist on the efficacy of the use of CAL in Science in Kenyan Universities. It is on this basis that this study sought to explore the effect of CAL on mastery of Science concepts in universities with a specific focus on experimenting, observation, and drawing of inferences. The study is geared towards informing policy formulations for enhancing uptake and improving learner performance in Science with the hope that this may encourage more learners to take up science and consider a career in science-related fields. Improved performance in Science and related subjects will act as a strong pillar towards the realization and achievement of Kenya Vision 2030, the Big 4 Agenda, and the United Nations sustainable development goals.

THEORETICAL FRAMEWORK

This study was based on cognitive load theory (Sweller, 1988), which focuses on the use of instructional methods that stimulate learners ability to efficiently apply mastered knowledge and skills to solve problems while taking into account the limited cognitive processing capacity of the human brain (Sweller, 2012; Sweller, Ayres & Kalyuga, 2011). CAL could, therefore, be an appropriate instructional method because it is multi-sensory approach that involves the use of all senses that stimulate learners' ability to solve problems and reinforce abstract concepts. It is equally learner-centered and focuses on achieving mastery of Science through experimenting, observation, and inferencing. These are proven methods of facilitating learning of Science, considering that the subject requires a lot of practicals and self-learning to internalize as opposed to memorization associated with the traditional learning methods.

The Objective of the Study

The objective of the study was to investigate the effects of Computer Assisted Learning on the learners' mastery of Science concepts in selected universities in western Kenya.

Research hypothesis

ISSN 2721-2904 (online)

$H_0$1: There is no significant difference in learners' mastery of concepts in Science between students taught using CAL and those taught using traditional methods.

METHODOLOGY

Research Design

The study adopted the Solomon Four Group Design (Solomon, 1949) whereby the eight universities selected for the study were divided into two forming experimental and control groups. The target population comprised of 8 universities in western Kenya with a population of 2460 first-year students enrolled in science-based programs. The sample size of 335 first-year students was determined by use of Krejcie & Morgan table (1970), who were then randomly selected based on the subject combination of biology and physics. First-year students were selected for the study because of the change of teaching approach and broadness of the subject content in universities as compared to secondary education.

The research design involved (i) Pre-testing one experimental and one control group; (ii) administration of treatment to two experimental groups; and (iii) administration of post-test to all groups. The study was carried out in 4 months spanning 16 weeks where pretest was administered after the first eight weeks of conventional teaching and post-test administered after the next eight weeks of treatment. Pre-test and post-test Science Achievements Test (SAT) on two topics, digestive system and light and optics were designed and administered by the respective lecturers, and scores were recorded. Trained computer laboratory technicians were used to assist lecturers in teaching using CAL.

The pre-test was done to enable the researcher to check the entry behaviour and to determine whether the groups were similar in character before being taught using Computer Assisted Learning.

Data analysis

The data were analyzed using both descriptive and inferential statistics. Descriptive statistics (mean, standard deviation, and percentages) were used to summarize the data. Inferential statistics involved the use of ANOVA to analyze differences in the means of the post-test scores to find out whether there was any significant difference -. t-test was conducted to determine whether a significant difference was present between the pre-tests and the post-tests of the group.

RESULTS

The pre-test scores for the learners are as shown in table 1 below.

Table 1: Learners Pre-test scores

Scale		Control group 1 (C1)	Experimental group 1 (E1)
Pre-test	N	89	84
	Mean	13.51	12.67
	standard deviation	4.33	4.35

The results in table 1 above show that at the point of entry C1 and E1 had mean scores of C1=13.5 and EI=12.67 and standard deviation of 4.33 and 4.35, respectively, which is an indication of homogeneity of entry behaviour.

To determine the relative effect of CAL on learners' achievement in mastery of Science concepts analysis of the learners' pre-test and post-test SAT scores were carried out, as shown in Table 2 below.

ISSN 2721-2904 (online)

Table 2: Learners Pre-test, Post Test scores and means scores and Mean Gain on SAT.

Scale		Control group 1 (C1)	Experimental group 1 (E1)
Pre-test	Mean	13.51	12.67
	standard deviation	4.33	4.35
Post-test	Mean	14.11	16.78
	standard deviation	2.77	3.68
Mean gain		0.59	4.15

After the study, Experimental group E1 had a higher (M=16.78, SD=3.68) mean score than that of (M=14.11, SD=2.57) the control group. The mean gain of E1 was also greater (M=4.15) than that (M=0.59) of C1. It was, therefore, necessary to perform a t-test analysis as shown in table 3 below since the mean results could not show whether the difference in mean gain between C1 and E1 were significant at the 0.05 level.

Table 3: Comparison of mean gain of groups on SAT

Df	t-value	p-value
75	2.851	0.006

The results in table 3 revealed that the difference in mean gain was significant at 0.05 level in favour of E1. This meant that the result of the mean gain analysis suggests that SAT enhances learners' achievement in the mastery of Science concepts.

The mean of the experimental groups E1 and E2 were generally higher than those of the control groups C1 and C2, as shown in table 4. This showed that CAL had an effect on improving achievement as compared with conventional methods.

Table 4: SAT Post Test mean and standard deviation

Group	N	Mean	Standard deviation
C_1	89	14.11	2.57
C_2	87	14.95	2.42
E_1	84	16.68	2.68
E_2	75	17.42	2.41

ISSN 2721-2904 (online)

In order to find out whether the differences were significant at 0.05 level, an ANOVA was performed, and results presented in table 5.

Table 5: One way ANOVA of SAT Post Test means score by learning method

Scale	Sum of Squares	Df	Mean Square	f-value	p-value
Between groups	237.506	3	79.169	9.695	0.0000x
Within groups	1257.538	154	8.166		
TOTAL	1495.044	157			

The results in table 5 revealed that the difference in SAT mean scores among C1, C2, E1, and E2 was significant at the 0.05 level. The results, however, did not reveal where the differences were. Accordingly, a multiple comparison test (post Hoc) was performed to reveal where the differences were, as shown in table 6.

Table 6: Multiple comparisons of SAT post-test mean scores

Groups	Mean Difference	p-value
C_1 v/s C_2	-0.55	0.863
C_1 v/s E_1	-2.28	0.007
C_1 v/s E_2	-3.30	0.000
C_2 v/s E_1	-1.73	0.067
C_2 v/s E_2	-2.47	0.003
E_1 v/s E_2	-0.75	0.723

- C_1 v/s E_1 is significant in favour of E_1
- C_1 v/s E_2 is significant in favour of E_2
- C_2 v/s E_2 is significant in favour of E_2

The result of the post hoc comparison analysis showed significant differences in favour of the experimental groups in that the subjects in the experimental groups outperformed the subjects that were in the control groups. It can, therefore, be concluded that the use of CAL seems to have led to relatively higher achievement than the use of traditional methods to teach the two areas of biology.

DISCUSSION

The study had sought to find out the effect of CAL on mastery of concepts in Science's topics of digestive system and light and optics. The results show that students taught using CAL achieved significantly higher scores in SAT compared to those taught through the conventional method. This could be attributed to the fact that CAL provided students with a multisensory approach to learning since the computer simulations and animations gave reality to abstract concepts through 3D presentations, which were easy to manipulate and observe compared to the traditional approach. The students could

ISSN 2721-2904 (online)

also learn at their own pace and review the concepts repeatedly without the computer becoming impatient or judgemental whenever a learner makes mistakes.

In the traditional method, the lecturer tends to dominate the class whereas in CAL neither the lecturer nor the learner dominates the process. CAL enhanced active manipulation of content and promoted interaction with content, and gave reality to abstraction. During CAL the lecturer's role remained as a guide, and this allowed learning to be learner centered by enabling learners to explore and sharpen their problem-solving skills, which could be key in the mastery of concepts in Science. CAL also facilitated learners to be able to observe and make repeated inferences to concepts, thus mastering them. These findings were in agreement with similar studies carried by Bayrak & Bayram (2010); Tareef (2014); Sharma, (2017); Bryson & Hand, (2007); Jang, (2008); Troisi, (2014).

The mean gain in performance could be attributed to the fact that CAL made the learners be practically oriented, which agrees with a study by Millar (2004) and Abrahams & Reiss, (2012), which concluded that practical skills enhance learners grasp of Science concepts and knowledge about Science. The experimental groups outperformed the control groups since they were able to master the selected process skills like experimenting, observation, and inferences better than the control groups. This finding is consistent with other studies that suggested that the application of technology improves thinking skills and the use of meta-cognitive abilities as well as the acquisition of content knowledge in Science education (Carmichael & Farrell, 2012; Hopson, Simms & Knezek, 2001).

CONCLUSIONS

Poor performance in science subjects has been attributed to the lose of critical manpower required to spur the economic growth and development of Kenya. However, as per the findings of this study, the introduction of CAL led to significant learning gains obtained by the learners exposed to treatment as compared to those not exposed to the treatment. Therefore, the use of CAL enhanced the acquisition of Science content, mastery of Science process skills that enable learners to understand the content deeper and equips them with knowledge for the future.

RECOMMENDATIONS

Based on the results, the study recommends the following: (i) a larger study to be carried out for generalization of results; (ii)Universities should incorporate the use of CAL in teaching and learning Science more so in topics involving experiments, making observation and inferences; (iii) universities curriculum developers should integrate CAL in the curriculum; and (iv) provide computers and computer training for teachers of Science to enhance the learning of science from universities.

REFERENCES

Abrahams, I., & Reiss, M. J. (2012). Practical work: Its effectiveness in primary and secondary schools in England. *Journal of Research in Science Teaching*, 49(8), 1035– 1055.

Abudu, K.A. & Gbadamosi, M.R. (2014). Relationship between teacher's attitudes and learner academic achievement in senior secondary school chemistry. A case study of 126 Ijebu-Ode and Odgbolu Local Government area of Ogun State. *Wudpecker Journal of Educational Research*, 3(3):35-43

Ainley, J., & Engers, L. (2007). Learner use of, and engagement with, information technology. *Curriculum Corporation*. https://research.acer.edu.au/digital_learning/11

Andae, G. (2019). KCPE scores drop on the back of low marks in Science. Business Daily. Retrieved from https://www.businessdailyafrica.com/news/KCPE-scores-drop/539546-5353786-n298x7/index.html

Bayrak, B. K. & Bayram, H. (2010). The effect of computer aided teaching method on the learners'academic achievement in the Science and technology course. *Procedia Social and Behavioral Sciences*. 9. 235–238

ISSN 2721-2904 (online)

Ben-Ari, M. (2001). Constructivism in computer Science education. *Journal of Computers in Mathematics and Science Teaching*, *20*(1), 45-73.

Black, T.R., Atwaru-Okello, D., Kiwanuka, J., Serwadda, D., Birabi, O., Malinga, F., Biumigishu, A., & Rodd, A. (1998). Science education in Uganda: progress and possibilities. International Journal of Science Education. 20(2). 239-252. https://doi.org/10.1080/0950069980200208

Bond, M., & Bedenlier, S. (2019). Facilitating Learner Engagement Through Educational Technology: Towards a Conceptual Framework. *Journal of Interactive Media in Education*, 2019(1): 11, pp. 1–14. DOI: https://doi.org/10.5334/jime.528

Bryson, C., & Hand, L. (2007). The role of engagement in inspiring teaching and learning. *Innovations in Education and Teaching International*. 44(4). 349-362. doi: 10.1080/14703290701602748

Buindi, B. (2013). Kenya Certificate of Secondary Education, Examination Results Released by Minister of Education. *Daily Nation, Nairobi*: Nation Media Group Ltd.

Cakiroglu, U., & Yilmaz, H (2017) Using Videos and 3D Animations for Conceptual Learning in Basic Computer Units. *Contemporary Educational Technology.* 8(4), 390-405 390,

Carmichael, E., & Farrell, H. (2012). Evaluation of the Effectiveness of Online Resources in Developing Student Critical Thinking: Review of Literature and Case Study of a Critical Thinking Online Site. *Journal of University Teaching and Learning Practice*, *9*(1), 4.

CEMASTEA (2017). Revealed: The Force Behind Learners' Performance in Science Subjects. Retrieved From https://www.cemastea.ac.ke/index.php/component/k2/item/236-revealed-the-force-behind-learners-performance-in-Science-subjects

Dina, T., Ciornei, S. (2013). Education Facing Contemporary World Issues the Advantages and Disadvantages of Computer Assisted Language Learning and Teaching for Foreign Languages. 5th International Conference EDU-WORLD 2012. *Procedia - Social and Behavioral Sciences*. 76(2013). 248 – 252 doi: 10.1016/j.sbspro.2013.04.107

Fafchamps, M., & Mo, D. (2018). Peer effects in computer assisted learning: evidence from a randomized experiment. Exp Econ. (21) 355–382. https://doi.org/10.1007/s10683-017-9538-z

Galang, N. M., & Galang, E. G. (2017). Computer Aided Tool in Science for Kindergarten Pupils. *Computer Science and Engineerin*g. 7(2): 45-51. DOI: 10.5923/j.computer.20170702.02

Hamilton, M., Mahera, W.C., Mateng'e, F.J., & Machumu, M.M. (2010). A needs assessment study of Tanzania Science education. Dar es Salaam, Tanzania: *The Economic and Social Research Foundation*

Hennessy, S., Wishart, J., Whitelock, D., Deaney, R., Brawn, R., Velle, L., McFarlane, A., Ruthven, K., Winterbottom, M. (2007). Pedagogical approaches for technology-integrated Science teaching. Computers & Education. 48.137-152.

Hopson, M. H., Simms, R. L., &. Knezek, G. A. (2001). Using a Technology-Enriched Environment to Improve Higher-Order Thinking Skills. *Journal of Research on Technology in Education.* 34(2). 109-119.

Jesuraja, B. (2015). Importance of Computer Assisted Teaching & Learning Methods for Chemistry. *Science Journal of Education*. Special Issue: Science Learning in Higher Education. 3(4-1).11-16. doi: 10.11648/j.sjedu.s.2015030401.13

Keengwe, J., & Onchwari, G. (2008). Computer technology integration and learner learning: Barriers and promise, *Journal of Science Education and Technology*. 17:560-565.

Kibet, K., Mbugua, Z.K., Muthaa, G.M. & Nkonke, G.R. (2012). Factors contributing to learners' poor performance in Mathematics at Kenya Certificate of secondary education in 130 Kenya: A case of Baringo County, Kenya. *American International Journal of Contemporary Research.* 2(6):87-91

Kothari R, (2004). Research methodology; methods and techniques. New Delhi, K.K Gupta

Krejcie R. V. & Morgan D. W. (1970). Educational and Psychological Measurement. 30, 607-610.

Majo, S., (2016). Factors Influencing Poor Performance in Science Subjects in Secondary Schools in Shinyanga Municipality, Munich, GRIN Verlag, https://www.grin.com/document/383487

ISSN 2721-2904 (online)

Maltese, A.V., & Tai, R.H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S students. *New Jersey: Wiley Periodicals*, *Inc.* 22

Millar, R. (2004). The role of practical work in the teaching and learning of Science. Paper prepared for the meeting: High school Science laboratories: Role and vision. Washington, D.C.: National Academy of Sciences.

Muzah, P. (2011). An exploration into the school-related factors that cause high matriculation failure rates in Physical Science in public high schools of Alexandra Township. *Unpublished Master of Education dissertation.* Pretoria: University of South Africa.

Mynbayeva, A., & Sadvakassova, Z., & Bakhytkul Akshalova, B. (2017). Pedagogy of the Twenty-First Century: Innovative Teaching Methods, New Pedagogical Challenges in the 21st Century - Contributions of Research in Education, Olga Bernad Cavero and Núria Llevot-Calvet, IntechOpen, DOI: 10.5772/intechopen.72341. Available from: https://www.intechopen.com/books/new-pedagogical-challenges-in-the-21st-century-contributions-of-research-in-education/pedagogy-of-the-twenty-first-century-innovative-teaching-methods

OECD (2016). Programme for International Learner Assessment (PISA) Result from PISA 2015.

Olatunde, Y. P. (2009). Learners' attitudes towards Sciences and academic achievement in some selected secondary schools in Southwestern, Nigeria. *European Journal of Scientific Research,* 36: 336-341.

Omondi, O.J., (2013). Factors Influencing the Choice of Science Subjects in Kenya's Secondary Schools: A Case Study of Langata High School in Nairobi County. Unpublished post diploma research project. University of Nairobi. Nairobi. Kenya

Sahin, S. (2006). Computer simulations in Science education: Implications for Distance Education. *Turkish Online Journal of Distance Education. 7(4)*

Sharma, R. (2017). Computer Assisted Learning – A Study. *International Journal of Advanced Research in Education & Technology*. 4(2). 102-105

Solomon, R. L. (1949). An extension of control group design. *Psychological Bulletin*, 46, 137–150.

Sweller, J. (1988). Cognitive Load During Problem Solving: Effects on Learning. *Cognitive Science*. 12 (2): 257–285. CiteSeerX 10.1.1.459.9126. doi:10.1207/s15516709cog1202_4.

Sweller, J. (2012). Human cognitive architecture: Why some instructional procedures work and others do not. In K. Harris, S. Graham & T. Urdan (Eds.), *APA educational psychology handbook*. 1. 295– 325). Washington, DC: American Psychological Association.

Sweller, J., Ayres, P., & Kalyuga, S. (2011). Cognitive load theory. NY: Springer.

Tareef, A. B. (2014). The Effects of Computer-Assisted Learning on the Achievement and Problem-Solving Skills of the Educational Statistics Learners. *European Scientific Journal*. 10(2). 271-279

Troisi, J.D. (2014). Making the grade and staying engaged: The influence of learner management teams on learner classroom outcomes. *Teaching of Psychology.* 41(2), 99-103. doi:10.1177/0098628314530337

U.S. Department of Education (2017). Reimagining the Role of Technology in Education: National Education Technology Plan Update. Washington, D.C.

UNESCO (2012). ICT in Primary Education Analytical survey. *UNESCO Institute for Information Technologies in Education*

UNESCO. (2005). Towards knowledge societies. UNESCO.

ISSN 2721-2904 (online)