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A Systematic Literature Review on Advances in Computer Assisted Instruction

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Abstract: The use of multimedia as a tool for delivering learning content instead of the traditional classroom learning practice is gaining popularity nowadays. CAI is the use of computer programs that are available both online and offline for instruction. The objective of this paper is to conduct a systematic literature review (SLR) on computer assisted (or aided) instruction (CAI) for five years period from 2018 to 2022 at all educational level. The objective of this study is to determine the research distribution on CAI, to identify the methods of data collection used in studies on CAI and to identify the types of CAI investigated in the research community from 2018 to 2022. This SLR uses review protocol for the selection of primary studies for inclusion in the study from the pool of literature available in the research community. The results of the review shows that the highest publication on CAI in the review period was in 2020 and most researchers used achievement test for collection of data on CAI in the reviewed period. The study also found out that 'Computer-Based Simulation' is the popular type of CAI used in experiments by researchers in the period of review. The use of CAI for teaching and learning activities enables flexible and efficient interaction among students and educators. This is a critical factor for enhancing learners' academic achievement. In conclusion, it is recommended that further research be conducted on CAI to promote its adoption in education systems.

Keywords: Computer assisted instruction, computer aided instruction, systematic literature review

1. Introduction

The popularity of internet and ICT facilities has motivated provision of online and digital services generally. These digital technologies are crucial for improving learning efficiency and high-quality education provision globally. Nowadays, many educational software packages are available online as well as on storage devices that enhances teachers' instruction in several ways. Use of computers for instruction enables learners' progress at their own pace. Therefore, computer assisted instruction (CAI) improves the quality of teaching and learning especially for students with learning disabilities, since learners receive feedback instantly. Furthermore, it allows learners perfect learning skill and procedure by repetition of specific learning task as an opportunity to master certain concepts quickly and effectively. According to Suson and Ermac (2020), computer assisted (or aided) Instruction (CAI) refers to the use of computer as a tool for enhancing instructional quality. In a nutshell, CAI is the use of computer software programs to improve teaching and learning activities in both the traditional and virtual classroom. The limited interactive nature of the traditional face-to-

face learning environment cannot provide sufficient flexibility for adequate understanding of the learning contents. According to Tirodkar and Lawrence (2021), the advancement of technology nowadays leads to increase in the use of CAI particularly in light of COVID19 pandemic. According to the authors, CAI enables learner-centred instructional approach that has potential of increasing academic performance and retention of learners. CAI is a powerful tool that capture learners' attention to engage in a competitive learning environment (Daramola, 2017).

Wang (2021) identified increase in learning content display in form of dynamic audio/visual as well as graphical and oral presentation of real-life phenomena among the benefits of CAI. According to the author, CAI is a software used for delivery of course content as scheduled in the syllabus. CAI simulation optimizes teaching by virtual imitation of impractical experiments that enhance students thinking and imagination capabilities. However, despite the numerous benefits of CAI in teaching and learning activities, it has challenges. Gao (2021) outlined lack of funds, lack of applicable software and hardware, lack of technical and theoretical knowledge as well as the need for rapid and constant update of both knowledge and technologies as the main problems faced in CAI. Similarly, Usman and Madudili (2020) identified poor maintenance culture and inadequate electricity supply as some of the factors militating the efficiency of CAI in Nigeria. Furthermore, Kaye and Ehren (2021) identified operating environment, learners' engagement, infrastructure, security and trust as some of the factors that influences CAI intervention in education systems. Typically, different types of CAI are applied to assist in teaching different subjects such as English, mathematics, History, Chemistry, Physics, Biology, etc. The types of CAI use for teaching these subjects comprise of drill and practice, tutorials, educational games, simulations and discovery/problem solving. The instrument for data collection used are questionnaire, Achievement test and interview.

The purpose of this study is to analyse the trends of research on CAI for the period from 2018 to 2022. This is to gain understanding of the existing recent research on CAI to enable researchers build knowledge in the field of education. The remaining part of this paper is organized as follows; section 2 outlined the objective of the paper. Section 3 presents reviewed literatures related to this study. Section 4 is for research materials and methods and section 5 reports the findings of this study. Finally, section 6 concludes the paper.

2. Objectives of The Study

The objectives of this study are;
  i)   To determine the research distribution on CAI from 2018 to 2022.
  ii)   To identify the methods of data collection used in studies on CAI from 2018 to 2022.
  iii) To identify the types of CAI investigated in the research community from 2018 to 2022.

3. Existing Literature Review on CAI

This section is essentially to describe previous research related to this literature review. A literature review by Sharma and Kumar (2017) on the role of CAI as teaching aid for children with special needs discovered that there is positive impact of CAI in educating children with special needs. Similarly, a review by Snyder and Huber (2019) studied on the effectiveness of CAI for teaching academic content to learners with intellectual disabilities. According to the author, CAI programs optimizes instructions by leveraging on dynamics of technology that increases learning outcome in special education. However, Vijoen, et al. (2019) evaluated the effectiveness of CAI on medical students' acquisition and retention of ECG competency. The study focused on comparative analysis to evaluate the efficacy of CAI over other methods of ECG instructions. Furthermore, the study analysed the efficiency of CAI in acquiring and retaining ECG competence among medical students. The result revealed that there was no evidence to show that CAI was better than face-to-face ECG instruction. Although, this study analysed vast areas of studies and discovered that blended learning is more effective than both pure CAI and face-to-face teaching methods. Overall, literature review and meta-analyses are nowadays used to analyse and highlight important aspects of published studies on a research topic. Particularly, meta-analyses and systematic literature review (SLR) are powerful tools that enables large-scale, unbiased and reliable evaluation of quality empirical evidence for valuable research direction.

A meta-analysis conducted by Sharifi, et al. (2018) evaluated the effectiveness of CAI for English language learning. The author compared experimental studies conducted on CAI and face-to-face English language instruction broadly. The study revealed that CAI has an intermediate effect on students' English language competency. Furthermore, the analysis revealed that learning context, duration of treatment, types of interaction and mode of communication affects English language learning development. Similarly, Dikmen and Tuncer (2018) reviewed on the effect of CAI on the academic achievement of learners by a meta-analysis approach. The author gathered 43 experimental studies in ten years period from 2007 to 2017. The result shows that CAI has a strong effect on students' academic achievement. Whereas, Bliss, et al. (2018) surveyed literatures on CAI in articulation of pronunciation using computer-assisted pronunciation training (CAPT) and articulated the popular types of visual feedback. Meta-analysis is a powerful tool for amalgamating several relevant studies and statistical analysis of published empirical studies in a scientific way. Meta-analysis is important in selection of good research topic in a logical and evidence-based manner. However, study selection conducted effectively by SLR is a prerequisite for meta-analysis. In view of the dynamic nature of research, review on recent advances in research on CAI is imperative.

An SLR by Tomesko, et al. (2017) conducted to evaluate the effect of CAI on learning physical examination of health science professionals discovered that CAI has no influence on knowledge and skill acquisition of health science professionals. However, a systematic literature reviewed by Bonsu, et al. (2020) explored the effectiveness of CAI on academic performance of history students. The result of the review shows that most studies discovered CAI enhances students' academic performance. Despite the potential of computer applications in improving learners' understanding and enhancing the quality of education generally. Research toward improving teaching and learning activities using computer application is not exhausted. The main contribution of this research article is; first, analyse research trends in CAI for the period from 2018 to 2022. Second, evaluate the instruments used for data collection in research on CAI within the period from 2018 to 2022. Finally, identify the types of CAI contents investigated in published article in the period from 2018 to 2022.

Despite the popularity of computer programs designed to enhance instruction in education systems, studies toward promoting the use of CAI are scarce. SLR is the preferred way to critically assess advances in research for further investigation and scientific decision-making. An SLR conducted by Tomesko, et al. (2017) covered from January 2001 to December 2016. Although, the study does not provide strong evidence that either CAI or face-to-face instruction support physical examination teaching for health science professionals. In addition, recent development in research needs to be investigated to update the research community on the advances made in these areas. Similarly, Bonsu, et al. (2020) conducted a systematic literature review on CAI in teaching and learning history in Africa. However, the study discovered that there is scarcity of research studies on the effect of CAI on academic performance of learners. Overall, the dynamic nature of technological innovation globally requires recent SLR in this research area commencing from 2018 to date.

4. Materials and Methods

This SLR is to identify and review relevant empirical studies on CAI from 2018 to 2022. This is to reveal advances and trends in research on CAI in the reviewed period. In addition, classify the identified articles according to research directions. SLR is usually conducted by review protocol to identify quality articles in an unbiased and dependable manner for inclusion in the study (Ahmed, & Letchmunan, 2015).

4.1. Review Protocol

The use of review protocol in SLR leads to thorough, robust and fair review results. The review protocol that guided the conduct of this study comprises research questions, search string, inclusion and exclusion criteria, study selection, quality assurance and data extraction.

a) Research Questions

RQ1: What is the research distribution on CAI from 2018 to 2022?

RQ2: What is the method of data collection used in studies on CAI from 2018 to 2022?

RQ3: What is the type of CAI investigated in the research community from 2018 to 2022?

b) Search String

The key terms relevant to answer the research questions and their synonyms was used to formulate the search string. The key terms are "advances" and "computer assisted instruction". The synonyms of advances in this context are "study", "effect", "impact", "influence". On the other hand, the categories of "computer assisted instruction" are "computer aided instruction", "computer simulation", "computer tutorial", "computer aided discovery", "computer games", "computer drill and practice". The synonyms were connected using the Boolean "OR", whereas the two aspects of the key terms with their synonyms was connected by the Boolean "AND". Consequently, the search string for this review is:

("Advances" OR "study" OR "effect" OR "impact" OR "influence") AND ("computer assisted instruction" OR "computer aided instruction" OR "computer simulation" OR "computer drill and Practice" OR "computer tutorial" OR "computer discovery" OR "computer game")

c) Inclusion and Exclusion Criteria

Inclusion Criteria

i) A primary study must be on CAI

ii) A primary study must be published within 2018 to 2022

iii) A primary study must be an empirical research article

iv) A primary study must be written or can be translated into English language

Exclusion Criteria

i) All primary studies that is irrelevant to CAI

ii) All primary studies published after 2022 and before 2018

iii) All primary studies not written in English language and has no translation.

d) Study Selection

All primary studies that passed the inclusion and exclusion criteria's screening was selected for further scrutiny. In other word, only relevant studies that are written or can be translated into English language and are published within 2018 to 2022 was included in this study.

e) Quality Assurance

The selected primary studies written in English language on CAI and published from 2018 to 2022 was gathered and filtered. First, selected primary studies was screened by the inclusion and exclusion criteria to remove all irrelevant articles. Second, relevant primary studies were stored in Mendeley reference manager to remove all duplications. Finally, quality evaluation was conducted by assessment of literature to ensure that primary studies is on CAI, primary studies provide description of the method of data collection used and primary studies clearly spelt-out the type of CAI investigated to ascertain its relevance in answering the research questions.

f) Data Extraction

To evaluate the quality of data in each selected primary study, data quality scrutiny was conducted as follows.

i) The researcher examines title, abstract and keywords of selected primary studies.
ii) The researcher retrieves full text of all relevant primary studies for critical evaluation.
iii) The researcher critically evaluates primary studies' eligibility.
iv) The researcher extracts all relevant data necessary to answer the research questions.
v) Finally, the researcher documents the extracted data in Data Extraction Form in Table 1.

Table 1 - Data extraction form

Publication Date
Author
Title
Method of Data Collection
Type of CAI Investigated

4.2. Conducting the Review

The conduct of this study is guided by a review protocol. The procedure for the conduct of this literature review is depicted by the flowchart in figure 1.
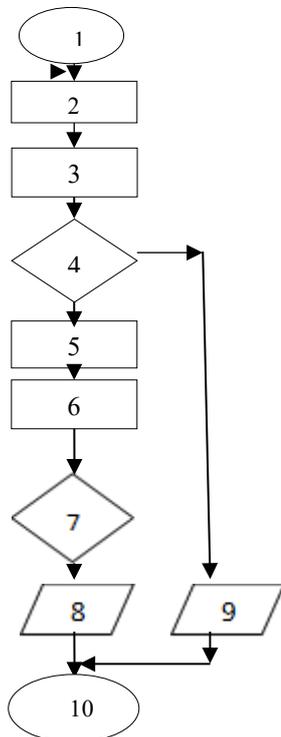
1. Start

2. Search using Search String

3. Read Title, Abstract & Keyword

4. Is primary studies relevant to   Research Questions?

5. If yes, then extract full text

6. Critically read the full text

7. Is there any relevant data?

8 If yes, then identify and record

9. Exclude irrelevant data

10. End

Fig. 1 - Flow Chart for Conducting the Review (Source: Ahmed & Letchmunan. 2015)

5. Results and Discussions

This section reports the findings and interprets the results of this study. The results of this study is organized according to the research questions in tables and charts for clarity as follows;

5.1. Yearly Number of Publications

The line graph on figure 2 shows changes in number of publications over time from 2018 to 2022 as a series of data points on the coordinate plane. The x-axis represents year of publication and the y-axis represent number of publication. The graph shows the number publications made each year for the period of five years.

No. of Publication
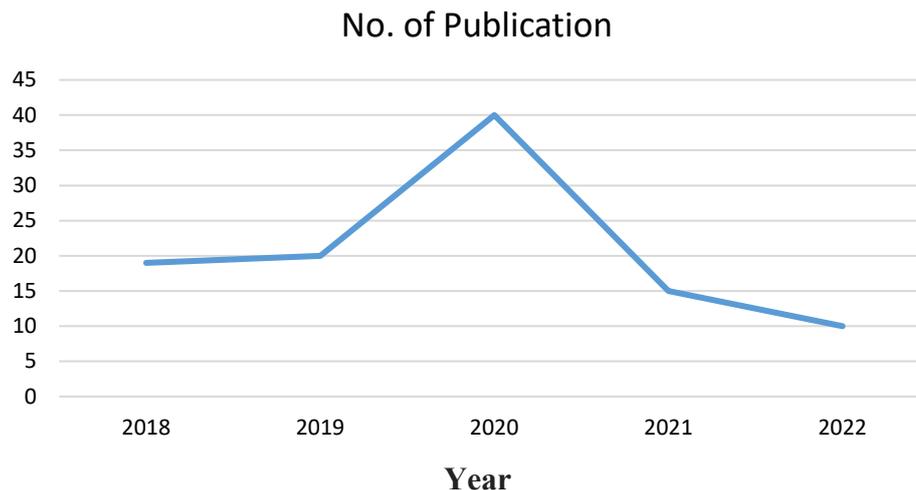
Year

Fig. 2 - Number of publication per year

To monitor the advances and trends as shown by the recorded number of research publications for the five-year period from 2018 to 2022. This is useful to show advances and trends in research on CAI clearly. It is found from the graph that the highest number of publications was in the year 2020 with 40 publications. Whereas, the lowest number of publications is 10 recorded in 2022. At the beginning in 2018, the number of publications recorded is 19. It then rose to slightly 20 number of publications in 2019 and escalate to its highest number of publications of 40 in 2020. Subsequently, the number of publications drops for two consecutive years in 2021 and 2022. The number of publications drops to 15 in 2021 and finally to its lowest number of publications of 10 in 2022.

The result of the review revealed that the unprecedented anxieties on the ability to apprehend COVID19 pandemic in the society worldwide drastically altered almost all aspect of human life. According to Ahmed (2021), education is one of the necessities of human being that is affected by the outbreak of COVID19 pandemic. The WHO directed the closure of schools as a precautionary measure to prevent the spread of COVID19 pandemic. This could be the reason for the drastic increase in research in 2020 globally to leverage on the remote instructional role of ICT in education system in the period of COVID19 lockdown.

5.2. Number of Publication per Instrument for Data Collection Used

The bar chart in figure 3 is to compare the methods of data collections used by researchers on CAI in the period of review. This is to understand the relationship between methods of data collection in research on CAI to determine how well they fit. The chart gives information about the number publication used in different categories of instrument for data collection between the years 2018 and 2022.
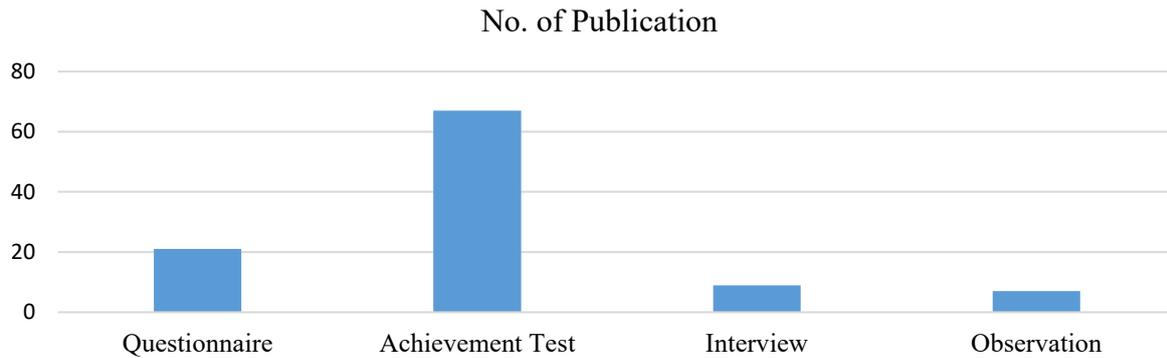
Fig. 3 - Instrument for data collection

According to the bar chart, there were fluctuation in the trends in the categories of instrument for data collection used for research in the review period. First, the lowest category of 7 number of publications used observation for data collection in the reviewed period and highest category of 67 number of publications used achievement test for data collection in the reviewed period. Whereas, 21 and 9 number of publications used questionnaire and interview respectively for data collection in the reviewed period.

Studies that used questionnaire for data collection include quasi-experimental studies conducted to evaluate the effectiveness of CAI for teaching geography and mathematics discovered that CAI enhanced students' performance and attitude in these subjects (Mwanda & Midigo, 2018; Kamalanehru & Bhavana, 2019). Also, Simarmata, et al. (2018) reported that use of CAI for tutorials improves students' interest in learning computer networks fundamentals. An evaluation of e-learning by computer-based problem solving for nutrition education students by Symond, et al. (2021) discovered that CAI is a useful method. A case study to assess students' ability by Suratno and Tonra (2018) discovered that CAI encourages students to be responsible for their learning. CAI is discovered to be an effective tool for improving ontolaryngology knowledge (Michael, et al., 2021). To evaluate the effectiveness of gamified CAI application in teaching chemistry by Bahingawan, et al. (2018) shows that CAI could serve as an additional teaching material. Kaya and Kirmizigul (2019) used quasi-experimental design for the effect of CAI and inquiry-based teaching approach without control group and discovered CAI as a more efficient method of teaching than inquiry-based teaching approach. Stelea and Giron-Gacia (2017) used mixed method for the effect of Jclic on students' performance, engagement and motivation in English language. The author discovered that use of Jclic for instruction can enhance learners' engagement, motivation and performance. Similarly, Trotti, et al. (2017) used mixed method of quasi-experimental and semi-structured interview to compare the effect of two CAI with control on the literacy learning for children at risk. However, the results shows that there is no significant differences in the performance of the groups.

Overall, the most popular method of data collection for research on CAI in the reviewed period from 2018 to 2022 is achievement test and least method of data collection used in the reviewed period is observation.

5.3. Number of Publication per Type of CAI Investigated

The pie chart in figure 4 gives information about how many numbers of publication recorded used each type of CAI in the reviewed period from 2018 to 2022. In the chart, the size of the sector of the circle represents number of publications for each type of CAI used in the experiment. According to the chart, it can be remarkably seen that computer-based simulation recorded the highest number of publications of 35 representing 32% of studies on CAI in the period from 2018 to 2022. Whereas, the lowest number of publications was recorded for gamification as the content of CAI experiment with 11 publications representing 10% of studies on CAI. The pie chart shows that 29 publications representing 27% used drill and practice in their CAI experiment. The other two sectors of the circle are for tutorials and gamification with 14 and 11 represents 13% and 10% of the publications respectively. Overall, the highest number of publications of 35 is recorded for computer-based simulation type of CAI and the lowest number of publications is 11 recorded for gamification type of CAI experiment in the review period from 2018 to 2022.

Fig. 4 - Types of CAI

A mixed method study by Trotti, et al. (2017) evaluated the development of literacy in children by using CAI. The result shows that there is no significant difference between vocabulary and letter recognition literacy in children taught with CAI. Furthermore, the quantitative data shows that there is no significant difference in awareness and overall literacy level of children taught with CAI. However, findings of the qualitative data shows that learning speed, students' motivation, literacy skills development and learners' technological proficiency development as some of the benefits of using CAI for children's teaching and learning at the early stage. Recent studies conducted on CAI at various level of education and in diverse subject areas revealed the need for investigating the effect of specific type of CAI on learners' performance and other aspects of learning such as attitude, motivation, engagement and retention.

6. Conclusion

The focus of this SLR is to identify all primary studies on CAI and evaluate the literature gathered from the research community from 2018 to 2022. This is important in view of the popularity of CAI in education systems in recent years. Usually, SLR uses review protocol to guide the selection of literature in an unbiased, transparent and reliable manner. The main contributions of this SLR results are outlined as follow: first, this study analysed trend in research on CAI in the period from 2018 to 2022, the review shows that the highest publication on CAI in the review period was in 2020. Second, this study evaluated the category of instrument for data collection used by researchers on CAI in the period from 2018 to 2022 and discovered that most researchers used achievement test for collection of data on CAI in the reviewed period. Third, this study identified computer-based simulation as the popular types of CAI content investigated in experiments by researchers in the period of review. In conclusion, it is recommended that further research be conducted on CAI to promote its adoption in educational systems. Research on the use of diverse method of data collection be conducted to enhance the quality of research in education system. Finally, it is recommended that future research on CAI should focus on the use of simulations, tutorials, drill and practises and games computer applications in experiments to promote the use of CAI in education system.

Most studies use quasi-experimental design with achievement test to evaluate the effect of CAI on students' academic performance in basic science, English language and technical installation maintenance (Adams & Onwadi, 2020; Mohammed, et al. 2019; Gngden & Gongden, 2019; Agbo, 2020). Other author used same approach to investigate learning outcome in physics (Nwoye & Okeke, 2020). Some authors focused on investigating the effect of CAI in learning motor vehicle mechanics trade, mathematics, agricultural science and biology [Abdulkadir & Mustapha, 2019; Mutlu & Akgun, 2017; Ardic & Isleyen, 2017; Lashley, 2017; Mbah, 2017; Sebeso, et al. 2017; Keraro & Wachanga, 2021). The results of these studies shows that CAI can enhance learners' academic performance. Similarly, an effort to determine the effect of CAI on the academic performance of college of educations' social studies students by Ekpenyong and Akwagioke (2018) found out that CAI enhances tertiary education students' academic performance. However, a study by Seker and Kartal (2017) shows that there is no significant difference in the academic performance of students taught science education with CAI and those taught in the conventional way. Similarly, a study by Estrella (2020) to assess the impact of CAI on the academic performance of grade 8 students of high school shows that there is no significant difference in the academic performance of students taught by CAI technology and those taught with traditional method. As a result, studies have shown that there is a controversy on efficiency of CAI technology as an instructional tool. Although, most reviewed studies discovered that the CAI is capable of enhancing students' performance in various subject areas. There are empirical studies that contradict these assertions. Consequently, further studies to investigate the effect of various types of CAI on academic performance of students on the teaching subject areas imperative.

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References

Abdulkadir, M., & Mustapha, A., (2019). Effects of Computer Assisted Instructional Technique on Students' Achievement in Motor Vehicle Mechanic Trade at Technical College Level in Niger State. *The Proceeding of the 5th International Conference on Education for Sustainable Development (ICESD-2019). 1*(1), 97-101.

Adams, S. O., & Onwadi, R. U. (2020). An Empirical Comparison of Computer-Assisted Instruction and Field Trip Instructional Methods on Teaching of Basic Science and Technology Curriculum in Nigeria. *International Journal of Social Sciences & Educational Studies, 7*(4), 22-35.

Agbo, N. M., (2020). Effect of Computer Assisted Instruction on the Academic Performance of Technical College Students in Electrical Installation and Maintenance Work in Enugu State. *British International Journal of Education and Social Sciences, 7*(4), 7-13.

Ahmed, M. M, (2021). ICT-Enhanced Instruction in COVID-19 Lockdown: A Conceptual Paper. International Journal of Case Studies in Business, IT, and Education (IJCSBE), 5(2), 386-398.

Ahmed, M. M., & Letchmunan, S. (2015). A systematic literature review on challenges in service oriented software engineering. *International Journal of Software Engineering and Its Applications, vol. 9(*6), 173-186.

Anthony, A., & Anka, S. S., (2020). Effects of Two Modes of Computer Assisted Instruction on Pupils' Achievement and Retention in English Language Spelling in Niger State-Nigeria. *International Journal of Innovative Research in Computer Science & Technology (IJIRCST), 8*(3), 231-241.

Ardiç, M. A., & Isleyen, T., (2017). Secondary School Mathematics Teachers' and Students' Views on Computer Assisted Mathematics Instruction in Turkey: Mathematica Example. *Malaysian Online Journal of Educational Technology, 5*(1), 46-64.

Bahingawan, R. M., De los Reyes, L. M. O., & Llanes II, T. R. (2018). Usability for Gamified CAI (Computer Aided Instruction) Chemistry Adventure RPG (Role Playing Game) for Grade Nine Chemistry Teachers using Adobe Flash. *Adobe Flash Journal, 1*(1), 1-4.

Bliss, H., Abel, J., & Gick, B. (2018). Computer-assisted visual articulation feedback in L2 pronunciation instruction: A review. *Journal of Second Language Pronunciation, vol. 4*(1), 129-153.

Bonsu, N. O., Bervell, B., Kpodo, E., Arkorful, V., & Edumadze, J. K., (2020). Computer-Assisted Instruction in the Teaching and Learning of History: A Systematic Review in Africa. *International Journal of Innovation, Creativity and Change, 14*(9), 584-605.
Daramola, F. O. (2017). Impact of Computer Assisted Instruction (CAI) and its Relevance to Teaching and Learning for National Development. *International Journal of Innovative Technology Integration in Education, 1*(1), 51-56.

Dikmen, M., & Tuncer, M. (2018).A meta-analysis of effects of computer assisted education on students' academic achievement: a-10-year review of achievement effect. *Turkish Journal of Computer and Mathematics Education (TURCOMAT), 9*(1), 97-121.

Ekpenyong, E. E., & Akwagiobe, A. B., (2018). Unmasking the effectiveness of computer assisted instruction in the teaching and learning of social studies in Cross River State College of Education Akamkpa, Cross River State, Nigeria. *Global Journal of Arts, Humanities and Social Sciences, 6*(7), 45-52, 2018.

Estrella, M. M., (2020). Impact of Using Computer aided Instruction (CAI) in the Performance of Grade 8 Students in Araling Panlipunan. *The URSP Research Journal, 6*(1), 31-36.

Gao, Y., (2021). Computer-aided instruction in college English teaching under the network environment. *Computer-Aided Design and Applications, 189*(4), 141-151.

Gongden, E. J., & Gongden, E. E., (2019). Effects of computer assisted instruction on male and female students' achievement in basic science in Jos metropolis, Plateau State, Nigeria. *American Research Journal of Humanities Social Science (ARJHSS), 2*(1), 27-35.

Kamalanehru, K., & Bhavana, A. R. (2019). Computer Assisted Instruction in Teaching of Mathematics: An Experimental Study at Higher Secondary School Level. *Journal of Education, 7*(2), 10-18.

Kaya, H., & Saylan Kirmizigul, A., (2019). Comparison of Computer-Aided Instruction and Inquiry-Based Teaching on Students' Anxiety towards Science. *The Turkish Online Journal of Educational Technology, Special Issue for IETC-ITEC, 2*(1). 72-77.

Kaye, T., & Ehren, M., (2021). Computer-Assisted Instruction Tools: A Model to Guide Use in Low-and Middle-Income Countries. *International Journal of Education and Development Using Information and Communication Technology, 17*(1), 82-99.

Keraro, P. K. R. F. N., & Wachanga, S. W. (2021). Original Paper Enhancing Biology Achievement of Secondary School Learners Using Experiential Computer Assisted Instruction. *International Education Studies and Sustainability, 1*(1), 59-77.

Lashley, L., (2017). The effects of computer-aided instruction in mathematics on the performance of grade 4 pupils. *SAGE Open, 7*(3), 1-12.

Mbah, L. U., (2017). Computer-Aided Instruction Usage and Primary Schools Pupils' Attitude and Performance in Mathematics in Jos Metropolis Plateau State, Nigeria. *Asia Pacific Journal of Multidisciplinary Research, 5*(4), 76-82.

Michel, M. C., Thal, A., Sparks, A. D., & Zapanta, P. E., (2021). Using Computer-Assisted Instruction to Increase Otolaryngology Education During Medical School, MedEdPORTAL, *The AAMC Journal of Teaching and Learning Resources, 17*(1), 1-7.

Mohammed, J., Yusuf, S. D., & Ibrahim, A., (2019). Effect of Computer-Assisted-Instruction (Cai) On Junior Secondary School Students' Achievement in Basic Science in Katsina Education Quality Assurance Of Katsina State. *FUDMA Journal of Educational Foundations, 2*(2), 240-250.

Mutlu, Y., & Akgün, L., (2017). The Effects of Computer Assisted Instruction Materials on Approximate Number Skills of Students with Dyscalculia. *Turkish Online Journal of Educational Technology-TOJET, 16*(2), 119-136.

Mwanda, S., & Midigo, R., (2018). Situating Constructivism in Learning and Teaching Arts Based Subjects; Focus on Learner Attitude Towards Use of Computer Assisted Instruction in Geography in Kenya. *International Journal of Scientific and Education Research. 2*(06), 91-104.

Nwoye, A. N., & Okeke, S. O. C., (2020). Effect of Computer Assisted Instruction (CAI) With Animation on Students' Academic Retention in Secondary School Physics. *Journal of the Nigerian Academy of Education, 16*(2), 209-218.

Sebeso, D., Hulela, K., Bulala, T., & Botswana, G., (2017). Effects of a Computer Aided Instructional Method on Students' Performance in Agriculture: A Quasi Experimental Case Study. *Life Science Journal, 14*(3), 58-64.

Şeker, R., & Kartal, T., (2017). The effect of computer-assisted instruction on students' achievement in science education. *Turkish Journal of Education, 6*(1), 17-29.

Sharifi, M., Rostami AbuSaeedi, A., Jafarigohar, M., & Zandi, B. (2018). Retrospect and prospect of computer assisted English language learning: a meta-analysis of the empirical literature. *Computer Assisted Language Learning, 31*(4), 413-436.

Sharma, S., & Kumar, S. (2017). Role of Computer Assisted Instruction (CAI) In Teaching to Children with Special Needs. *Bhartiyam International Journal of Education & Research, vol. 6*(3), 16-22.

Simarmata, J., Limbong, T., Napitupulu, E., Sriadhi, S., Tambunan, A.R.S. and Sinaga, E.K., (2018). Learning application of multimedia-based-computer network using computer assisted instruction method. *International Journal Engineering Technology, 7*(2), 341-344.

Snyder, S., & Huber, H. (2019). Computer assisted instruction to teach academic content to students with intellectual disability: A review of the literature. *American Journal on Intellectual and Developmental Disabilities, 124*(4), 374-390.

Stelea, S., & Girón-García, C., (2017). Computer-assisted instruction: 'JClic'as a new pedagogical tool for EFL learners. *International Journal of Education and Development using ICT, 13*(1), 4-31.

Suratno, J., & Tonra, W. S. (2018). Computer-assisted guided discovery learning of algebra. *In Journal of Physics: Conference Series, IOP Publishing. 1028*(1), 1-6.

Suson, R. and Ermac, E., (2020). Computer aided instruction to teach concepts in education. *International Journal on Emerging Technologies, 11*(3), 47-52.

Symond, D., Nur, N. C., Arza, P. A., & Diana, F. M., (2021). Problem Based Learning Teaching Approached in Nutrition Counselling Topic of Nutrition Education Subject by e-learn Computer Assisted Instruction of Undergraduate Nutrition Students at Public Health Faculty of Andalas University. *In The 3rd International Conference on Educational Development and Quality Assurance (ICED-QA, Atlantis Press. 3*(1), 618-620.

Tirodkar, S., & Lawrence, A. (2021). Changing the Face of Education: Computer-Assisted Instruction in the Secondary Education Classroom. *Journal of Student Research, 10*(3), 1-9.

Tomesko, J., Touger-Decker, R., Dreker, M., Zelig, R., & Parrott, J. S. (2017). The Effectiveness of Computer-Assisted Instruction to Teach Physical Examination to Students and Trainees in the Health Sciences Professions: A Systematic Review and Meta-Analysis. *Journal of Medical Education and Curricular Development, 4*(1), 1-11.

Trotti, J., Hendricks, R., & Bledsoe, C., (2017). Emergent Literacy Development and Computer Assisted Instruction. *SRATE Journal, 26*(1), 30-39.

Usman, Y. D., & Madudili, G. C., (2020). Assessment of the impact of computer assisted instruction on teaching and learning in Nigeria: A theoretical viewpoint. *International Journal of Education and Development using Information and Communication Technology, 16*(2), 259-271.

Viljoen, C. A., Millar, R. S., Engel, M. E., Shelton, M., & Burch, V. (2019). Is computer-assisted instruction more effective than other educational methods in achieving ECG competence amongst medical students and residents? A systematic review and meta-analysis. *BMJ open. 9*(11), 1-19.

Wang, X., (2021). Research on the Application of AI Technology in Computer-Assisted Instruction. *In Journal of Physics: Conference Series, IOP Publishing. 1*(1), 1-5.