Journal of Education, Teaching, and Learning
Volume 7 Number 2 September 2022. Page 166-175
p-ISSN: 2477-5924 e-ISSN: 2477-8478

A SYSTEMATIC REVIEW OF FACTORS THAT INFLUENCES THE EFFICACY OF COMPUTER BASED LEARNING

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Abstract. Despite emerging evidence from research studies showing positive influence of computer based learning on quality of education and academic achievement of learners, there is very limited research studies that synthesises factors that influence or contributes to the success or effectiveness of computer based learning methods. The purpose of this systematic review was to synthesise factors that influences the efficacy of computer based learning. We followed the protocol from preferred reporting items for systematic reviews and meta-analyses (PRISMA). Major electronic educational databases were searched. In total, 20 studies that met inclusion criteria were reviewed in this study. After completing thematic analysis of the included studies, findings revealed that students' characteristics factor such as attitudes, self-discipline, prior knowledge of computer use and motivation, also infrastructure factor such as easy access to computer and availability of technology influenced the efficacy of Computer Based Learning. Recommendations from the research reports are discussed.

Keywords**:** Computer Based Learning; Online Learning; Academic Achievement

I. INTRODUCTION

The switch to remote learning following the outbreak of COVID-19 has slightly changed how educational contents and activities are being delivered in schools. Prior to the Covid 19 pandemic, most schools used the traditional teaching style, which consisted of students arriving in class on time and teachers covering the usual content of their subjects, sometimes through formal lectures. The switch to remote forms of contact, virtual meetings that limit face-to-face contact in order to protect students and teachers from exposure to the coronavirus has made schools to further embraced alternative means of schooling (Huber & Helm, 2020).

Teachers had to adapt to online teaching, which necessitated the use of a variety of digital tools and resources to address problems and adopt new teaching and learning strategies (Eickelmann & Gerick, 2020). Many academic institutions that were initially hesitant to modify their traditional pedagogical approach were forced to switch completely to online teaching and learning in the form of computer-based learning.

Computer based learning refers to the use of computers in education for the purpose of delivering programs, facilitating communication between students and teachers, or allowing students access to remote sources of information (Solaipriya & Suresh, 2019; Wondemtegegn, 2018). According to Patel (2013) computer based learning presents content and provides quick feedback for students using a combination of text, images, sound, and video in various modalities such as tutorials, simulations and drill and practice. According to previous research, computer based learning in educational contexts functions as a catalyst for change in the way education is transmitted (Cheok et al., 2017). This is because the use of CBL has made knowledge dissemination, quizzes, tests and examinations much easier (Ahlan et al., 2014).

There are many research findings in literature to show that good implementation and use of CBL can help students study more and achieve higher grades in school. For example, Serin (2011) reported from the findings of the study conducted that the experimental group that received computer based learning had a statistically significant boost in their academic achievement. Likewise, Jesse et al., (2014) investigated the impact of CBL on science subjects' performance among Kenyan secondary school students. The results of their research revealed that students who were taught using CBL performed much better in science subject

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than students who were taught using conventional instructional methods.

Furthermore, in a study to assess the effects of computer-based learning on secondary school students' achievement in chemistry, Charagu (2015) found that students in the experimental group (computer based learning) performed significantly better in chemistry than students in the control group who were not exposed to computer-based learning. Similarly, Olakanmi et al., (2016) reported from the findings of their study aimed to determine the effects of CBL in promoting intrinsic and extrinsic motivation among senior secondary students, that students who were taught chemistry using CBL had higher intrinsic and extrinsic motivation and achievement than those who were taught using traditional teaching methods.

On the contrary, some studies reported that computer based learning method has no or little effects on academic achievement of students (Peterson & Roseth, 2016; Hsiao et al., 2014; Lin et al., 2014; Razon et al., 2012). The explanation for the disparity in results of these studies from literature could be attributed to a variety of factors, including students' characteristics such as attitudes of learner towards computer based learning, emotional supports from teachers and parents or infrastructures factors such as easy access to computers.

In support of this view, Serdyukov (2015) as well as Choi et al., (2012) alluded that learners with positive attitudes towards learning are more likely to succeed academically in school, most especially in the contemporary context of computer based learning because of the challenges it poses. In addition, Tseng et al., (2011) noted that the success of computer based leaning requires that learners rely on intrinsic motivation and self-directed learning. This is because developing positive learning attitudes is instrumental for leaners to stay motivated in a challenging learning environment (Tseng et al., 2011).

The support that learners receive from their teachers and families could contribute to positive learning attitudes (Martin & Bollinger, 2018). Specifically, encouraging children to be confident and supporting their educational endeavours and achievements have been found to be the most helpful forms of emotional support needed for learners to develop more positive attitudes and dispositions towards learning (Keller, 2015; Hoidn and Kärkkäinen, 2014; Kunter et al., 2013).

On the teacher's side, the research study reveals that learning environments in which teachers are able to convey enthusiasm for the topic of their lesson help students establish positive learning attitudes (Keller, 2015). The role of teacher enthusiasm as a motivator for student positive learning attitudes has been well documented: for example, passionate teachers assist their students in developing positive subject-related affective experiences and a feeling of the subject's personal worth (Keller, 2015).

Despite emerging evidence from research studies showing positive influence of computer based learning on quality of education and academic achievement of learners, there is very limited research studies that synthesises factors that influence or contributes to the success or effectiveness of computer based learning methods. A systematic review of enablers and factors that enhances the efficacy of computer based learning is needed so as to reveal and focus more on specific factors that are instrumental in making computer based learning efficient (Naveed et al., 2020; Seyhan 2015).

Against this background, the purpose of this systematic review was to synthesise factors that influences the efficacy of computer based learning. In line with this purpose, the specific research question for this study is: What are the factors that influences the efficacy of computer based learning

II. METHODS

This study made use of systematic literature review. SLR is a valuable type of research designed to identify, appraise, and synthesize the best available data while also rigorously following the principles of scientific procedures (Boland et al., 2017). We conducted a rapid literature search of empirical studies on computer based learning published from 2011 to 2021. The purpose of the literature search was to find all studies that reported on the effectiveness of computer based learning on academic achievement of learners.

We looked through the following database (a) Educational Resources Information Center, (b) Africa wide Information (c) PsycINFO (d) CINAHL (e) Academic Search Complete (f) SAGE. Our search terms include computer, computer-based instruction, computer-assisted learning, computer based learning, computer-augmented instruction, computer based education, computer supported collaborative learning. In addition, we added the keyword effectiveness, effect, efficacy, academic achievement and academic performance to each of the terms mentioned earlier.

We began by reading all of the titles and abstracts that came up in our searches. Following the identification of a potential study, the entire article was analyzed to see if it fit our inclusion criteria. Only studies that matched all of the following criteria were considered: (a) the study examined the efficacy of computer based learning on academic achievement (b) the study assessed effectiveness using objective performance or learning indicators (such as test results) (c) the study compared data from a control group that was taught using traditional methods and an experimental group that was taught using computer-based learning (d) the control group were not exposed to any form of computer based learning. Exclusion criteria includes (a) articles not related to computer based learning (b) case studies (c) articles that were not published in peer review journals. The Fig below depicts the flow diagram for the study selection:

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p-ISSN: 2477-5924 e-ISSN: 2477-8478

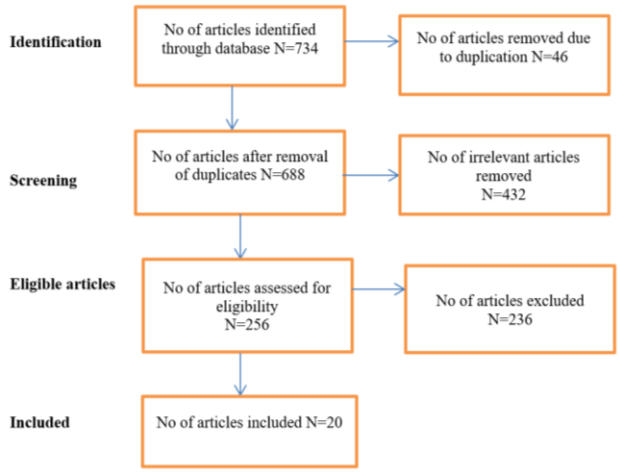

Fig 1: Flow diagram for the study selection

As depicted in fig 1, a total of 734 articles were identified through the search. We screened the abstracts of these articles to remove duplicates. This reduced the number of articles to 688. The articles were further screened to remove irrelevant. As a result, the articles were reduced to 256. We further scrutinised the articles based on the stated inclusion and exclusion criteria, hence 20 articles were included for review.

Coding method

Following the identification of studies that match the inclusion criteria, a coding system must be utilized to conduct the comparisons in the next stage. The coding approach should be broad enough to accommodate all research while still being specific enough to distinguish them (Ozcan, 2008). The coding procedure for this study included three main sections and a total of 10 questions. The first section was called ‘study identity’. There were 6 questions in this section. For the purpose of defining the study identity, information such as the number of studies, the names, the names of the authors, the year and location of the study and the name of the publisher were included. The second section comprised 3 questions and was titled "study content" (Ozcan, 2008). Information pertaining to the year and name of school where computer based learning was used; the length of instruction, criteria used in selecting the participants and the details of the computer based learning being used was gathered. The third and last component was titled "study data". This part included descriptive statistical data such as sample size, mean values, and standard deviation values for the experimental and control groups.

Data analysis and synthesis

Based on the final search results, 25 papers were found to be suitable for the review, the majority of which were quantitative in nature. According to Clarke (2017), systematic review does not require to aggregate the results of the studies to offer an average estimate when there is such heterogeneity in methodology. As a result, narrative synthesis utilising thematic analysis was used to synthesise data in this study (Ritchie et al., 2014). Percy et al., (2015) asserted that thematic data analysis is a general technique to identify, analyse and report patterns across data.

We followed 6 steps when synthesising data, usimg thematic analysis; we familiarised with the data by reading and reading it again, at the same time, we started developing codes. We generated initial codes from the data with reference to the research questions. This systematic classification method and identification of meaningful data as it relates to primary and secondary research questions are referred to as coding (Braun & Clarke, 2006). The third phase included the search for themes to identify what is relevant in the themes and what is not. We included any reference to factors that make computer based learning effective. This prepared the foundation for us to begin the analysis of potential codes. In the process of developing themes, we described the meaning of the different themes. During the fourth phase, we searched for data that support the answers to our research questions. This provided room for further development and review of the themes as they evolved. During this process, some themes that emerged earlier caved-in into each other while other themes were compressed into smaller units. During the fifth phase, we defined and named each theme as well as the data that was being captured.

We worked collaboratively throughout the process, checking and criticising each other’s work to reduce any bias and promote trustworthiness, as Saldana (2015) suggested. We each completed the theme analysis on half of the articles then swapped work to double check each other’s findings and met to discuss any area of dispute or uncertainty. The 20 papers examined in this systematic review study are profiled in Table 1 below:

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p-ISSN: 2477-5924 e-ISSN: 2477-8478

Table 1
Profile Of Studies Included For Review

Studies	Research design	Participant and sample	Reported Potential influencing factor	Focus of the study
Bianchi et al., 2020	Descriptive Survey	Chinese students N(130)	Computer skills, Access to computers.	Effect of computer assisted learning on student long term development.
Bayraktar (2012)	Quantitative survey	N=42	Low Student computer ratio, Effective assessment.	Effectiveness of computer aided instruction in social science education
Kinyua (2017)	Quasi experimental	Art and design student N=450	Computer literacy, Access to personal computer, Access to internet.	To find out the extent to which computer based instruction could improve learners performance in arts and design
Aderinsola (2019)	Mixed method	N=2337	Regular power supply, Internet access.	To examine the effect of computer based learning on academic performance of students in Nigeria
Julius 2018	Quasi experimental	Chemistry students N=174	Access to personal computer, Equipped computer laboratory.	To investigate the influence of computer aided instruction on students achievement in chemistry
Halabi et al., (2010)	Pre-post-test quasi experimental design	N =84	Collaborative learning, Prior computer knowledge.	To compare the effectiveness of CBL and face to face learning
Khobo (2015)	Quantitative research approach using quasi experimental design	N=100	Leaner's attitude, Learner's interest, Convenience.	To investigate the effect of using computers in leaning mathematics
Sosa et al., (2011)	Quasi experimental design	N=145	Learners engagement, Learners self-control, Frequent use of computers.	To determine effectiveness of computer assisted instruction in statistics
Suleiman et al., (2017).	Descriptive survey	Grade 9 students N=46	Working in a group, Easy access to computers	To examine the effect of computer assisted instruction on the academic achievement of secondary school students in physics
Mohagheghzadeh et al., (2014)	Descriptive survey	N=120	Computer skills, Computer literacy level.	The impact of computer based learning on the academic achievement of medical and dental students
Sanico (2019)	Analytical survey	N=130	Prior knowledge of computer skills, Learner's attitudes towards education.	Impacts of Computer based learning on students' academic performance
Rosa (2012)	Descriptive survey	N=500	Students' Attitudes towards CBL, Prior knowledge of computer based technology, Access to computer based technology tools.	Factors influencing integration of Computer based learning

Ganotice et al., (2019)	Survey	Health and social care students N=531	Motivation, Individual students' preparedness.	Factors that enhance students success in computer-supported team based learning
Agbo (2015)	Mixed method	N= 147	Accessibility to ICT infrastructure.	Factors influencing the use of CBL in learning mathematics
Overfield & Bryan-Lluka (2013)	Quantitative survey	N=106	Previous knowledge of computer skills, Learning style, Motivation	To evaluate factors affecting computer based learning
Hebebci et al.,(2020)	Qualitative narratives	Teachers N=16 Students N=20	Unrestricted interactions, Provision of computer facilities	To investigate the views of students and teachers on effectiveness of Computer based learning
Cerezo et al., (2017)	Quantitative longitudinal	N=140	Time management, Self-discipline	To investigate factors that influence success of CBL
Higgins et al., (2019)	Quantitative survey	N=200	Students' Attitude, Motivation	To examine the effect of CBL on students' academic achievement in mathematics
Naveed et al., (2020)	Descriptive survey	N=150	Attitudes towards learning, Student motivation, Computer self-efficacy, Commitment towards CBL, Appropriate timely feedback, Understandable content, Up to date learning materials	To evaluate critical success factors in implementing CBL
Cidral et al., (2018)	Quantitative method	N=170	Good internet speed, Learning at one's own space, Effective assessment Ease of access	To examine CBL success determinants

III. Result and Discussion

After completing thematic analysis from the synthesis of the included studies, two main descriptive themes emerged as factors that influence the efficacy of computer based learning. The themes are students' characteristics factor and infrastructure and technology factor.

A. Theme 1: Students' characteristics factor

1) Attitudes of learners towards learning

Attitudes are the beliefs and feelings learners have towards learning using computers. Findings from most of the 20 studies reviewed in this study indicated that students' attitude towards computer based learning is a determinant of its efficacy. Reports from the studies indicated that learners with positive attitudes towards computer based learning performed better in their subjects. It appears that the level of knowledge acquired by learners when using computer based learning method is moderated by their attitudes towards use of computers. It is thought that if learners believe that computer-based learning is not a good enough method of learning, they would not prioritize learning through computer based.

The right attitude towards learning is relevant to computer based learning. This is because affective dispositions are important determinants of students' subsequent behaviour. In other words, attitudes of students towards learning affect their enthusiasm for studying. Therefore, it is important for students to develop positive attitude towards computer based learning in order to enhance its efficacy.

2) Self discipline

The vast majority of studies reviewed highlighted that self-discipline influenced the efficacy of computer based learning. Efficiency of CBL requires high level of student self-discipline because teaching and learning might not take place under the direct supervision of a teacher as it is the

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case in a face-to face teaching and learning in the classroom. CBL increases the possibility of learning anytime in a virtual environment. Yet, students need to devote more time to their studies. Therefore, to avoid distractions and procrastination, students need to demonstrate high level of self-discipline.

Self-discipline entails concentrating on activities that aid academic achievement such as doing school work in time and reviewing notes. Self-discipline impacts school related activities such as time management and reading. Learners with high level of self-discipline are much better able to control their daily and routines activities and as a result, usually avoid distractions. Most studies reported from their findings that knowledge acquisition which consequently determines the efficacy of CBL is significantly high among high self-disciplined students.

3) Computer literacy level

Computer literacy refers to the knowledge and skills required to effectively use computers and technology. Based on the 20 studies we reviewed in this study, we found that most studies indicated that prior knowledge of the use of computer contributes to the efficacy of CBL. The studies further indicated that the degree to which learning could be efficient using computer based learning is dependent on learners' computer literacy level.

Computer literacy level is significant because it improves learners' capacity to perform tasks that are required for computer based learning to be effective. When computer literacy level of students is high, there ICT skills is enhanced which influenced the use of computer facilities. As a result, learners become more efficient and have access to information which facilitates better result. Ability to access information on the computer is necessary to achieving success in computer based learning. Majority of the studies reported that learners who have fundamental computer literacy skills achieve higher test scores when learning is computer based.

4) Motivation

Two thirds of the studies reviewed reported motivation and student preparedness as one of the factors that influence the efficacy of computer based learning. The findings of these studies considered motivation as a significant factor of academic success since it energizes and guides learners' behaviour towards achieving goals. Almost all literature reviewed found a significant relationship between student's intrinsic and extrinsic motivation and academic achievement when using CBL. It could, therefore, be inferred that highly motivated learners who are able to study independently are the most likely to take advantage of computer based learning.

Self-Motivation is a key factor in academic success and it can aid in making CBL as successful as possible. Motivation help direct learners attention towards completing academic tasks that is needed to be done thereby minimizing distractions. The perception of how simple or difficult computer based learning can be influenced by student motivation. It seems when learners are motivated, there is a reduction in symptoms of indifference and apathy towards computer based learning.

B. Theme 2 Infrastructure and technology factor

1) Easy access to computer

Twelve out of the twenty studies which represent 60 per cent of the number of studies included in this review, revealed from the findings of their studies that students who had easy access to computer had significant progress in their academic achievement when using CBL. Availability and accessibility of computers is required to fully access learning resources that is needed to take part in learning using CBL method. In other words, computer access is essential for achieving the needed flexibility that makes CBL work.

Most of the aforementioned studies reviewed concluded that access to computers has significant contribution to the efficacy of CBL. The main reason for this outcome appears to be the ability to incorporate the use of computers in day-to-day learning activities. A further reason given on why accessibility of computers may enhance the success of CBL from the findings of studies reviewed is that, learning practices involving computers may boost reasoning skills of learners.

2) Availability of technology

Many of the studies revealed that students are more engaged in instructional activities that incorporate technology because it helps them understand their subjects and provides different ways of expressing knowledge, which has a beneficial impact on their academic performance. However, report from these studies indicated that technology could be beneficial to learning if learners had significant access to it. Use of Technology affects students' attitudes toward learning positively. Findings from the studies show that when technology is a routine part of students learning experience, computer based learning become interesting for students.

Technology has made it possible to disseminate knowledge instantly and to communicate feedback more quickly and effectively in the field of education. Regular and constructive feedback enhanced learners' engagement. Feedback enabled learners to set greater performance goals. Instant feedback which is made available with the use of technology help to inform learners about their current level of knowledge acquisition and the effort they need to put in to achieve their goals.

Discussion

Several studies in the literature, conducted with various sample groups in various subjects, have reported the efficacy of computer based learning strategy in enhancing learners' academic achievement (Watson et al., 2020; Gündoğdu & Korucu, 2018; Huang et al., 2017; Takaci et al., 2015). In line with this, this study synthesised factors that are instrumental in making CBL effective. The findings of this systematic review indicated that students' characteristics factor and infrastructure factor influenced the efficacy of Computer Based Learning.

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We found from the reviewed carried out in this study that students' characteristics such as attitudes of learners towards learning, self-discipline, computer literacy level and motivation substantially account for the effectiveness of CBL. These findings correspond to findings from previous research and add to overall knowledge on significance of student attributes on the success of a teaching/learning approach as determined by academic performance of students.

For instance, Choi et al., (2012) reported that students who achieved high in mathematics had a positive attitude towards learning mathematics using computer based learning approach. On the other hand, Awang, et al., (2013) reported that students who had negative attitudes towards modern learning approach such as computer based learning were found experience difficulties in learning which consequently affected their academic achievement negatively. Thus, it appears students attitudes towards CBL is a determinant of its success.

The importance of students' self-discipline is generally recognised for successful implementation of CBL. This is because student self-discipline is a basic prerequisite to make CBL effective. Some research findings indicated that student self-discipline has a discernable effect on student learning outcome (Cerezo et al., 2017; Sosa et al., 2011). Disciplined students are more likely to stay focused on their educational objectives, manage their time effectively, avoid procrastination and distractions and demonstrate determination to succeed in academics. Computer based learning approach requires learner to demonstrate high level of self-discipline because of it flexibility which allows the possibility of students to work on learning materials anywhere with less supervision, which in turn impact their study habit positively. In consistent with findings of other studies (Anila, 2016; Duckworth, et al., 2011), student's self-discipline appears to have a positive impact on the efficacy academic performance as revealed in this study.

Prior knowledge and ability to use computer efficiently influenced the efficacy of CBL. Based on the findings gathered from the studies included in this review, Students who had prior exposure to the use of computer find it more efficient and seamlessly easy to learn using computer based approach (Bianchi et al., 2020; Kinyua, 2017; Halabi et al., 2010). This finding resonates with the findings of Sansone et al., (2011) who noted that students who already have a prior knowledge of computers may display greater interest in computer based learning because they may already possess the skills required to access learning materials needed for successful implementation of CBL.

Learners need motivation to learn. Most of the studies that investigated the influence of students' motivation on efficacy of CBL reported that student intrinsic and extrinsic motivation contributes to the success of CBL (Ganotice et al., 2019; Overfield & Bryan-Lluka, 2013; Higgins et al., 2019). Furthermore, findings from the retrieved papers included in this review revealed that students motivation may be the catalyst required for CBL to be effective (Higgins et al., 2009).

Similarly, the findings of the review conducted in this study suggested that infrastructure factor and availability of technology also influenced the efficacy of Computer Based Learning. It emerged in our review that among factors that influence effective integration of computer based learning in curriculum content delivery is easy access to computer. The findings of the research reviewed were consistent with much of the literature. Many studies found that students who had easy access to computers performed better academically than those who had limited or no access (Aderinsola, 2019; Julius, 2018; Bayraktar, 2012). One explanation given for this is that easy access to computers increased access to information and learning resources which in turn increase students' progress (Nawaz & Khan, 2012).

Limitations and Strengths

There are some limitations to this study. First, electronic databases were used in the search, and efforts were made to find all relevant publications related to factors that improve the efficacy of computer-based learning. However, some studies may have been omitted because some papers from other databases might met the inclusion criteria but not included in our analysis due to the nature of the search process. Due to the vast number of research found in the Web of Science literature search, the few studies would not have had a major impact on the findings of this study. We also attempted to address this potential constraint by conducting a brief post-hoc search using Google Scholar, which revealed that there are relatively few new sources available.

Second, we did not contact any authors to request additional data or relevant studies, which could have resulted in publication bias. Furthermore, studies usually only report significant findings, while non-significant findings are either not reported or not provided enough data to compute effect estimates. As a result of the reporting criterion for non-significant findings, the efficacy of CBL may be positively overstated.

Many schools have permitted students to bring their own devices into the classroom in recent years, as well as incorporating digital table tops, smart boards, and other technology. As a result, the outcomes of this study are only applicable to computer-based learning environments. The impact of new and emerging technologies on student achievement could be the focus of future review research.

The approach to the literature was one of this study primary strength. This research was carried out with the use of a thorough search technique and a detailed data extraction approach. The outcome of this review revealed several policies and implications, and the potential benefit which were summarised in the next section.

IV. Conclusions

The findings of this study will help learners, teachers, facilitators or instructors as well as other stakeholders to better understand factors that might contribute to the effectiveness of computer based learning. To make informed recommendations, we interpreted the findings of the revised

synthesis. Based on the information available, efficacy of computer based learning is influenced not only by students' characteristics factor but also infrastructure and technology factor. Being well informed regarding enabling factors that enhances the effectiveness of CBL is essential when designing and implementing computer based learning system.

The outcome of this review suggested that CBL has the potential to increase learners' knowledge and academic performance if learners have positive attitude towards learning, self-disciplined, motivated, have prior knowledge of computer and also have easy access to computers. Therefore, classroom teachers need to gain new information and skills to enable them adapt face-to-face teaching and learning approach to computer based learning especially with the emergence of COVID-19, which has altered the way educational materials and activities are presented in schools. This is necessary because the education sector has not fully gone back to the traditional way of teaching since Covid-19 is still present worldwide. Measures of social distancing, wearing masks, and using sanitizers to prevent the spread of the virus are still active.

To this end, efforts should be made to increase access and opportunities for students to use computer-based learning for their studies. Governments at all levels should make computer sets with internet connectivity affordable and accessible to students and teachers to use in the teaching and learning process. In addition, workshops and seminars should be organised for students to intimate them with the identified factors that influence the efficacy of computer based learning in order to enhance their academic performance.

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