Active Learning Multi-Strategies

Ibtehal Nafea

Abstract*: The competitive educational environment and globalization promote the adoption of multiple strategies that instill effective learning. Embracing different learning strategies helps keep the students focused and engaged. Not only this, but it also helps to evaluate the grey areas in their learning. The active learning improves student's engagement and helps develop a conducive learning environment. Given this, the study investigates the effectiveness of active learning in computer science (CS) students. Primarily, it illustrates the active learning multi-strategies and how they positively contribute to the learning environment. A cross sectional design is used following a quantitative approach. The data is gathered from 74 students through a survey using a close-ended questionnaire. These students were enrolled in two different semesters, which was then statistically analyzed. Results showed that self-study improved the students learning outcomes by 77% for first semester students and by 78% for second-semester students. Effectiveness of peer review was 72% and 70%, while for clickers, it was 62% and 63%, respectively. The use of multi-strategies is instrumental in improving students learning. Such as, it helps increase learners' knowledge, confidence, and constructive interaction in the classroom setting.

Keywords: **Active Learning, Clickers, Education, Flipped Classroom, Programming Course, Role Play.**

I. INTRODUCTION

Pedagogically, learning preferences and techniques incorporated vary for every individual [1]. Even though the same curriculum is followed in the classrooms, teachers are required to induce innovative strategies for meeting the diverse need of the students [2]. This need has given rise to a new concept known as active learning. Active learning emphasis teachers to eradicate the use of conventional teaching practices and adopt contemporary teaching techniques necessary for teaching the students of generation Z [3]. According to Fletcher [4], leaning dynamics have changed, which requires teachers to integrate and synergize innovative teaching strategies, which adds to the competitiveness of the students. This also works in the multicultural environment that persists across the learning institutes. Previous studies have shown that active learning strategies improve students' learning outcomes and knowledge retention [5,3]. Another study by Freeman et al. [3] observed that by inducing the classroom curriculum with active learning strategies, the test score of the students was high in contrast to the students who were taught using traditional approaches. [6] demonstrates that 75% of the students demonstrate better results through increased participation in using active learning strategies. The recent statistics indicate that learners that have taken up active learning approaches have managed to increase their exam scores and decreased the failed tests for active learning [7]. [8] states that independent learning improves student's self-confidence, which eventually progresses their academic performance. [9] adds that improved participation in active learning have postulated innovative activities and created a conducive learning environment. Furthermore, active learning also assists in overcoming challenges such as identification of the knowledge gap among the learners, the difficulties they face, and the methods that can be deployed for overcoming it. Computer science is a stream that explores how to utilize computers for solving real-world issues. Thereby, it is important for creating an active learning environment for enhancing comprehension and retention of material for students, allowing students for taking control and regulating their own learning, and consequently empowering them with essential skills for solving issues outside of the classroom. Studies have also indicated that active learning is particularly effective for computer science students who have tendency to be intuitive or visual learners. It is essential for continuing to own inquiry as computer science instructors on whom individual process information and correspondingly learn explicitly and authentic approach for achieving the objective to keep students involved in an active learning environment. How can individuals effectively utilize adequate and functional dynamic instructional technologies for addressing this objective of applied understanding? Will spending significant energy and time attending to an active learning environment address this query? What is the level of autonomy and independence which students can be offered for stimulating an empowering and active learning experience? This study seeks for providing an explanation of the existing state of active learning research by examining the utilization and justification of the idea of active learning research and the measurement approaches of learning findings in active learning research. This paper is contextualized in computer science education as teaching in this discipline and information technology related subjects have conventionally been more instructor-focused and content-oriented as compared to student-centered. On the contrary, computer science education has witnessed a progressively growing interest towards active learning and produced stimulating outcomes on the efficacy of active learning in published studies. Thereby, in this specific context, taking a look at the phenomenon of active learning is further beneficial due to its high value to the overall higher education. The extent of research examined in this study intends to expand understanding of the researchers of the existing state of knowledge regarding the methodological examination and conceptual use of active learning and for providing methodological and theoretical directions for future research.

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***** Correspondence Author
Ibtehal Nafea*, Computer Science Department, College of Computer Science and Engineering, Taibah University. Email: inafea@taibahu.edu.sa

Additionally, the study intends to offer guidelines for instructors to improve their critical and theoretical understanding of active learning in higher education.

II. LITERATURE REVIEW

Various studies have validated that active learning increase learners' content knowledge, enriches their learning experience, develops critical thinking and problem-solving skills, and enhances their enthusiasm and positive attitudes towards learning [10,11]. The literacy of the information also improved communication and interpersonal skills. [12] describe that these methods develop learners' cognitive skills that eventually enable them to succeed in their academic endeavors. The methods work better when they are incorporated to complement one another. The incorporation of the strategies varies, considering the course being taught [13]. Hence, it is in the class teacher's position to determine the most effective approach for learning to take place. It is important to note that active learning does not just happen; a teacher must create an appropriate environment for it to occur. [14] supplements that shun the passive modes of teaching that are often ineffective.

Similarly, the teaching methods adopted for teaching Computer Science (CS) are being modified driven by the increased popularity of active learning [15]. This has further raised several challenges in terms of pedagogical needs, such as providing students with active learning experience [16]. Some of the strategies that are exercised in learning institutions included flipped classroom, peer review, clickers, and role-playing. For example, the teaching of programming has been perfected through the stated teaching methods; however, they are exercised independently. Evaluation of the previous researches provides that incorporation of the active learning strategies in the discipline of computer science remains a foreign concept. Such as either the studies are too old [17] or focused on a certain strategy such as flipped classroom, peer review, and clickers [16,18,19]. Also, [20] survey of the computer science student showed that only 20% of the teaching faculty used active learning strategies while remaining relied on the traditional approach of content delivery. Based on the paucity of the information in the existing computer science field, lack of integration and advancing incorporation of the computer technology, the present study evaluates the effectiveness of the active learning strategies among CS students. This is also driven due to the programming needs of the learners require them to actively participate in learning activities instead of being passive listeners or receivers. Thereby, the strategies incorporated include peer review, clickers, and the flipped classroom. A number of instructors have been enthusiastic for making efforts for new procedures and for reporting them to their fellow instructors as interest in active learning has expanded. For instance, [21] recommend that action research is an adequate approach for computer science educators for studying active learning in their instructional practices. On the contrary, the research on active learning is not regardless of issues. For instance, measurement methods of learning and their authenticity are rarely reported in the active learning studies [22]. In addition, a review study [23] showed that instructors actively piloted novel teaching methods regardless of executing any research on them even though they agree with researchers regarding the direction of Finnish educational development. [24] reviewed studies that had implemented simulation studies and reported that majority of the studies were only explanations of procedures regardless of offering any systematic evidence on their impacts on learning. Additionally [25], have reviewed studies on experiential learning strategies and reported that the methodological examination revealed that the outcomes did not fulfill the highest of research design as well as measurement standards, and; therefore, can establish tentative conclusions regarding the exact efficacy of approaches. [26] noted that deepened evaluation of active learning is usually complicated as studies do not often consider a wider range of findings and the outcomes are usually mixed or a matter of interpretation. Comprehensively, additional discussion is still required on the measurement methods of active learning research.

A. Peer Review

Peer review is an established teaching strategy which helps improve the student's skillset and teaching quality. Various scholars have recognized it as an efficient method for the development of information literacy among students [27,28]. It is efficient in validating documents, especially student assignments, and increases networking capabilities. Generally, peer review involves peer project assessment, collaborative working, and information sharing [28]. Often, peers have a certain type of target which, in this particular case, is classroom success. Hence, through peer grading or feedback, they get into the position of developing the targeted knowledge understanding [29].

Peer review is believed to help develop cognitive abilities and the collaborative environment among the learners [30]. For instance, in a writing class, an instructor can ask a student to read and respond to his peers' writing sample. This practice produces double impact; one for the student who reviews and others for the student whose paper is being reviewed. This activity improves students' critical thinking, their ability to develop responses, formulate, and communicate helpful reactions, and effectively respond to the feedback. Additionally, this review helps an instructor to assess the evaluation skills of the student and its application. However, this technique neglects the fact that a student may be unable to review the paper. [31] introduced and popularized peer review as a learning technique. Preliminarily, peer review has been expanded to other areas such as computer science courses among STEM faculty [32]. Peer review involves students via activities throughout the class, which allows the instructors for identifying any learning issues or misunderstandings among the students about the core notions experienced [31]. The instructor merely continues to the next planned topic in a typical peer review class if approximately 75% of the students have adequately answered the contextualized questions. Otherwise, students are stimulated for discussing the answers among themselves in order to convince colleagues that their viewpoint is appropriate.

The peer review technique is often encouraged by technological devices including smartphone applications or clickers. There are several positive aspects associated to the use of peer review. In particular in computer science, peer review is collaborated with cooperative learning in different courses in order to verify a reduction in the number of students that received lower grades or pull out from the course [33]. Consequently, a positive impact was found in a study performing peer review strategy with in-class quizzes and pre-class activities on grades and passing rate of computer science students [34]. Peer review elevates the self-efficacy and exam scores of students than conventional lecture-based learning [35].

B. Clickers

[36] insists that embracing technology has an advantage in the development of active learning pedagogies. The use of clickers enables anonymous answering during class sessions [37]. This allows the instructor to sample the answers and give feedback to learners instantly. This method keeps learners' alert, providing a more engaging environment. This active learning approach is believed to complement and even surpass the other dynamic learning approaches. Mostly because it hides the identity of the student who provides specific answers, which motivates others to participate without fear of being embarrassed or shy. Furthermore, it integrates the 'game approach' that is comparatively more engaging as compared to the traditional teaching approaches [19]. However, the widespread use of clickers is yet to be discovered, which pinpoints the need to mobilize more learning institutions on its significance [38]. Consequently, scholars have identified it as operative because of its formative and summative characteristics that provide an engaging and active learning experience [38,39]. It can also provide feedback for class discussions, peer assessments, and the fundamental teaching and learning process. It also supports the student learning process as it allows for a student-centered environment. Hence, it is easy to assess individual student needs, and a student can take the initiative to improve on their areas of weakness. The positive applications of clickers might not be interactive to this pedagogy. On the contrary, clickers implement techniques presumed by other non-technological active learning pedagogies other than learning activities, which include asking students for responding to a particular question implied by a facilitator [40,41]. Studies have found that there are no differences between conventional classrooms and clickers on exam performance or differences on exam performance are comparatively minimal when controlling for such similarities [40,19,42,43]. There have been mixed insights regarding the overall advantages of clickers [44]. It has been observed that researchers previously presented performance advantages, other argued if advantages are present, they are minimal and possibly outweighed by financial and technical limitations. It is recommended that research investigating student viewpoints of clickers in combination with student performance can be vital in decisions for or alongside clicker use in the classroom. Additionally, there are several techniques an instructor can bring into the classroom that generate preferable student findings [45]. It is problematic that a number of studies investigating clickers have compared this classroom involvement strategy with control methods undertaking arguments that research on a particular educational technique can compare with established or standard practices [46,47]. This study intends to explain that clickers have a positive influence on student learning outcomes and viewpoint as compared to non-active learning control methods. On the contrary, the paucity of evidence comparing clickers to other influential active learning strategies makes it complicated for making a valid comparison to established active learning classroom strategies as compared to outdated control techniques.

C. Flipped Classroom Approach

This strategy is often referred to as 'schoolwork at home and homework at school.' The method allows instructors to inculcate a variety of methodologies in their classes, improving the learners' content retention ability. Students have more control over their learning. By having short class lectures at home, they have the freedom to learn at their own pace. This improves one's performance since there is more time to understand concepts and review content without lagging in classwork. The lecture videos made enable learners to catch up quickly, especially when they do not manage to attend classes [48]. It also gives the teachers flexibility when they do not participate in classes and even eliminates makeup assignments. This form of learning also nurtures the learner's skills through collaborative projects and discussions in their classes. This facilitates peer education under the guidance of the class teacher. Students develop the ability to own the knowledge they have through partaking in their learning process. In turn, students develop their confidence, and their behavior in class improves as well. This method is effective in extra hours, which allows students to practice their academic learning. In addition, it allows parents to track the progress of their child through their constant access to video lectures. This enables parents to better understand the course and offers insight concerning the educational quality that is being delivered. [49] asserts that this method is practiced across different institutes since it focuses on the student's use of conceptual knowledge rather than factual recall. Establishing material for flipped classrooms is a confronting task and different instructors have different tactics. Some instructors and institutions are already reporting their lectures for the objective of online courses, which make it comparatively easier for such instructors for leveraging those resources in their flipped classes [50-52]. On the contrary, this can refer to very long created videos. Recorded lectures are not preferred by all students as may argued that sometimes the lectures were explicit and not adequate for complicated course materials [50]. Majority of the students recommended that optimal video length of lectures must be 15-30 minutes [51,52]. Therefore, the three strategies are adopted in the current study alongside the traditional approaches for evaluating their impact on the students learning. The findings are suggested to be helpful for the teachers in devising new study plans for improving students learning competence.

III. Materials and Methods

A. Study Design

An action research design following a quantitative approach is used. It is selected as it efficiently draws unbiased statistical results. Accordingly, existing researches have established its efficacy for drawing concrete findings [11,28]; however, the present study differs from these in terms of its' objective and scope.

B. Study Population and Sample

Computer science students are categorized as the study population. The sample is derived as per the inclusion criteria which recruits students enrolled in first and second semester only. 74 students were included for evaluating the effectiveness of the active learning strategies.

C. Data collection

Data was collected through a survey using the close-ended questionnaire. The questionnaire comprised of 9 items based on the 6-point Likert scale. The gathered details include participants with demographic information as well as the effectiveness of teaching strategies. Before its distribution, the reliability was assessed using Cronbach Alpha, while, three social science experts reviewed it for its validity. Further changes were made based on the received feedback.

D. Ethical Consideration

Ethical clearance was obtained from the Institutional Review Board (IRB), while participants were communicated the study goals, the confidential and anonymous handling of data, and their right to withdraw at any point of the study. A written consent form was also acquired from the participants.

E. Study Assessment Procedure

Students were assessed based on their understanding of the programming concepts that are needed in the course. Different assessment techniques were deployed, including peer review, flipped classroom, and clickers to support student learning. In this case, the same approaches and survey were used among two students in two different semesters.

First, with peer review, students commendably assessed their capabilities in the field. Through their instructor's guidance, they sought clarification on various concepts regarding course objectives. The students worked in groups enhancing their positive independence and individual accountability. Each group reviewed other groups' feedback about their work.

Secondly, using the flip method, the learners have links to the class lectures that they review before class activities, which motivates their self-learning and independence. The students were instructed to explain what they have learned and how they moderated the class discussion. Also, clickers have been used at the end of every session to assess the class' performance using their mobiles through Poll Everywhere application. Clickers also provide the instructor with any misconception in the student answers and can provide students with early feedback in the class.

To fully bring to light the impact of their training, short exercises were given, in the form of questions. This acted as an evaluation of the quality of all that is delivered.

F. Data Assessment

The gathered data were statistically analyzed using SPSS IBM Version 20.0. Results were represented in the form of percentages to identify the effectiveness of active learning among CS students.

IV. Results and Discussion

The Cronbach alpha was achieved to be 0.967, signifying towards the high questionnaire reliability.

Table- 1: Questionnaire Reliability

Cronbach's Alpha	N of Items
0.967	9

Table 1 exhibits the student's response enrolled in the first semester. It indicates that the methods applied were adequate for the majority of the students. Self-study activities were preferred by 77% of the students, followed by peer review (70%), clicker (62%), role-playing (55%) and flipped classroom techniques (31%). Low results were obtained by increasing the number of instructors (30%), problem-solving group (24%), and summative assessment (38%). Homework for learning was found to be favorable for 46% of the students.

Table- 2: Survey responses (first semester)

Questions	Excellent	Very Good	Good	Acceptable	Need to improve	Unacceptable
Using the method of learning via videos. (Flipped classroom)	24%	31%	23%	null	15%	7%
Using mobile applications such as poll everywhere in learning. (Clickers)	62%	24%	Null	7%	7%	null
Numerous instructors of the same course.	30%	30%	17%	16%	Null	7%
Exchange of roles between the instructor and student, for example, giving the student a chance to teach (Role changing).	55%	30%	Null	15%	Null	Null
Using the group work method (problem-solving group).	24%	62%	Null	7%	Null	7%
Use the method of evaluation/self-assessment among students (Peer review).	70%	15%	15%	null	Null	Null
Homework	46%	30%	17%	7%	Null	null
Additional questions and helper sites help that sent by e-mail for self-study (Self-study).	77%	Null	15%	8%	Null	Null
The variety of exam questions (Summative assessment).	38%	9%	38%	null	8%	7%

The responses of the second-semester students are indicated in table 3. It provided that the online assigning of the task through email which required self-study was high (78%) following the peer review technique (72%).

Clickers were preferred by 63%, and role changing by 57%. Surprising results regarding the flipped classroom were obtained as only 28% considered it to be excellent. The summative assessment was high among the second-semester students (41%). Also, 30% of the students showed inclination towards the traditional approach of content delivery by increasing the number of instructors while for the problem-solving group, it was 26%. Similar to first semester students, the homework was preferred by 47% of the second-semester students.

Table- 3: Survey responses (second semester)

Questions	Excellent	Very Good	Good	Acceptable	Need to improve	Unacceptable
Using the method of learning via videos. (Flipped classroom)	28%	30%	21%	1%	15%	5%
Using mobile applications such as poll everywhere in learning. (Clickers)	63%	25%	2%	5%	5%	null
Numerous instructors of the same course.	30%	29%	18%	17%	Null	6%
Exchange of roles between the instructor and student, for example, giving the student a chance to teach (Role changing).	57%	30%	Null	13%	Null	Null
Using the group work method (problem-solving group).	26%	60%	2%	6%	Null	6%
Use the method of evaluation/self-assessment among students (Peer review).	72%	14%	13%	1%	Null	Null
Homework	47%	32%	16%	5%	Null	null
Additional questions and helper sites help that sent by e-mail for self-study (Self-study).	78%	12%	10%	null	Null	Null
The variety of exam questions (Summative assessment).	41%	16%	38%	null	Null	5%

The differences in the perceptions of 1st year and 2nd year students are presented in Table 4 with respect to the use of different active learning strategies. According to the findings, it was found that there was positive and significant difference between the uses of active learning strategies. Students in both years were using flipped classroom strategy, summative assessment, peer review, problem solving group, role changing, and clickers, and found significant differences individually.

Table- 4: Paired Sample T-test between 1st Year and 2nd Year Students w.r.t to different active learning strategies

Strategies	F	Sig	T	Mean Difference
Flipped classroom	0.811	0.001	0.238	.517
Summative Assessment	0.028	0.001	0.945	.192
Peer Review	0.397	0.003	1.620	.343
Problem Solving Group	0.456	0.006	1.241	.226
Role Changing	0.107	0.028	.177	.033
Clickers	0.018	0.015	.695	.125

The findings revealed that the students were impressed with the application of peer review and the use of clickers. These approaches positively impacted their learning. Unlike other methods, these encouraged self-study, enhancing their anticipation for exams. The findings are endorsed by the previous studies such as [53], who exhibited that peer review improved 86% of the science students learning competency. Along with it, [45] endorse the effectiveness of the clicker's information of a conducive learning environment augmenting the learning capacity of the students.

A good number also agreed with role-playing, where they would be allowed to teach; this enhanced their confidence in classroom activities. These are in line with the research evaluation of [54], which demonstrated its effectiveness in the professional development of teachers. Homework also proved to be useful since it boosted learning without the usual use of formal examinations. [55] support these findings, which also used online homework practice among the students and illustrated improved academic performance.

Contrary to this, video uplinks were thought to be ineffective by some learners since they could not have one-on-one contact with instructors and immediate response to their questions. [56] endorse these results by illustrating the negative attitude of the students towards the video, which often acts as a distracting factor. 6-7% of the students disliked the multiple instructors teaching approach since they believed it would negatively affect their results, which is similar to the results of [57]. According to it, multiple instructions from a different teacher make the student frustrated negatively impacting their learning. In the current study, few students disagreed with the summative nature of the exams, contrary to the findings of [58] study which reported the effectiveness of the summative assessment.

This could be because most of them were not well prepared, hence developed a negative opinion on the papers. Additionally, some students disliked the group work technique since they were not comfortable to engage or bond with strangers, which impacted the learning outcomes. Whereas, the summative form of assessment reflected improved grades, indicating the efficiency of the applied teaching approaches in the second-semester students.

It recommends future researches to evaluate the effectiveness of active learning across different educational stages. Such as students belonging to different domains can be selected other than computer science. Furthermore, an experimental design of the study comparing pre and post results of the students' academic performance can be carried out for expanding the knowledge in the existing field. It is important for using interactive approaches in education. Active learning strategies are still not considered as renowned approaches even though recent years have observed increased research on such strategies. Teacher skills should be developed both in the design and transforming their materials as well as in the utilization of technological equipment for disseminating these approaches. In addition, it is suggested to expand computer science students on these active learning strategies over the years for exploring whether their perceptions are changed. This study offers evidence that these perspectives elevate as the active learning strategies were integrated over the years. Higher education must entail computer science content in their curricula through such methodologies that can facilitate learning in an adequate approach as employers are commencing to be aware of the need for training in computer science courses. The study has recommended that universities need commitment to computer sciences and the enhancement of transversal competences of higher education students when using active learning strategies for reaching reflexive learning. Furthermore, the flipped class strategy assists in elevating the commitment to information technology in the labor market as the findings revealed it is higher in students who are working.

Several limitations were identified to be taken under consideration. Firstly, this study is based on six active learning strategies for computer science students. However, the study has only included students from 1st and 2nd years; therefore, further research is required to explore the evidence regarding 3rd and 4th year students. Secondly, this study has covered only one university, and it is probable that the same survey done in another university or region would not reveal the same outcomes. Thirdly, the study is based merely on the measurement of students' perceptions, and the measurement of perceptions of educators must be further conducted to compare both perceptions of active learning strategies.

V. CONCLUSION

The study concluded that the traditional approaches in teaching and learning are often faced with several challenges which impede the learning process. With the case study on students in two semesters, this study provides insights on different approaches that can improve students' learning and education quality. The learning outcomes from the incorporation of the flip method, use of clickers, and peer review exceeded the expectations demonstrating a positive impact on student learning. These procedures can be implemented in different educational settings creatively for improving the students' educational outcomes and academic success.

APPENDIX

Statement	Excellent	Very Good	Good	Acceptable	Need to improve	Unacceptable
Q1: Using the method of learning via videos. (Flipped classroom)						
Q2: Using mobile applications such as poll everywhere in learning. (Clickers)						
Q3: Numerous instructors of the same course.						
Q4: Exchange of roles between the instructor and student, for example, giving the student a chance to teach (Role changing).						
Q5: Using the group work method (problem-solving group).						
Q6: Use the method of evaluation/self-assessment among students (Peer review).						
Q7: Homework						
Q8: Additional questions and helper sites help that sent by e-mail for self-study (Self-study).						
Q9: The variety of exam questions (Summative assessment).						

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AUTHORS PROFILE

First Author Dr. Ibtehal Nafea, PhD, is an assistant professor at Computer Science Department, College of Computer Science and Engineering, Taibah University. Dr. Ibtehal's work has been published in Journal of Network and Computer Applications and International Journal of Parallel Programming. She is also a reviewer in Advances in Science, Technology and Engineering Systems Journal (ASTESJ), the CCPE Journal Special Issue and The Journal of Systems and Software. She is a member of Artificial intelligent research group and scientific research unit in computer Science College., Taibah University. Saudi Arabia, Medina. She was a member of technical committee in WiDS Medina 2020 and IRICT 2020. She participated in many conferences