Journal of Engineering Education Transformations ,
Volume 36 , No. 4 , April 2023 , ISSN 2349-2473, eISSN 2394-1707

10.16920/jeet/2023/v36i4/23125

From Observation to Active Learning: A Collaborative Learning Approach for Object Oriented Programming Course

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Abstract: Collaborative learning using Active Learning Strategies (ALS) and Information Communication Technology (ICT) tools in programming subjects facilitate the students-instructors into effective ways to make everyone engaged in Teaching Learning Process. In such learning, learners required to respond one another's ideas. Teachers are the key players in collaborative learning process by launching the learning environment, accommodating student requirements and ensuring the classroom activities. In this study, benefits of ALS and ICT tool usages have been analyzed for the Object-Oriented Programming course offered to engineering undergraduates. The impacts are analyzed in terms of teaching methodology, practicing lab, pass percentage, course outcome attainment, internal and terminal test performances and course exit survey. The outcomes indicate that, ALS and ICT approach yields positive result in performance.

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Keywords: Collaborative Learning, Active Learning Strategies, Information and Communication Technology, Online Learning, Object Oriented Programming, Course Outcome, Pedagogy.

1. Introduction

The traditional way of teaching learning in many academic institutions is almost passive and mostly operates in isolation (Magana, 2018). The teacher stands in the classroom as the highest authority, retains rigidity and follows the structural method of delivery of information. It is difficult to attract the attention of all students and they often do not engage in classroom events in many cases. Various students may have a diverse approach to learning and adopt various methods of learning (Zuber, 2018). One of today 's promising pedagogical processes is learning through the active learning strategies and using ICT resources.

Students should be able to analyze material from different directions in the most effective education framework. Collaborative learning is an approach to education that facilitates student engagement and mutual accountability for academic achievement. It enhances the active learning which is designed to engage students actively in the learning process through discussion with their peers (Varma-Nelson, 2020; Lin, 2017; Powell, 2017).

Active learning techniques include effective collaboration between peers, peer review and problem-solving skills (Magana, 2018; Cherney, 2008; Prince, 2004). Instructors opting for the use of collaborative and active learning platforms, particularly those that are free and in accordance with the abundance of Learning Management Systems (LMS), can cultivate at most engagement between students and instructors for a specific class or course, and demonstrate the vital element of instructor commitment to learning and attainment. Effective utilization of ICT tools in teaching-learning provides the student centric opportunity and offers student-to-student and teacher-to-teacher collaboration and communication. Increased access, material accessibility, learner-centered approach, new ways of interaction and a combination of learning and doing (Silva, 2018) are the key benefits of using ICT from the student perspective.

From the year 2018 onwards, Our Institution follows Conceive-Design-Implement and Operate (CDIO) framework to implement teaching -learning process. Previously, we adopted the Outcome-based Education (OBE) curriculum and further, the Choice-based Credit System (CBCS) (Rajivlochan, 2017). The CDIO Syllabus focuses on individual, interpersonal and system building skills and leaves a student with the punitive fundamentals necessary for any particular field of engineering. It harmonizes and significantly expands on ABET's criteria. The benefits of CDIO framework are as follows: It increases active participation and learning through hands-on; it emphasizes problem identification and solution and generation of prototyping; Students thoroughly explore the underlying concepts of the tools and techniques of engineering. For each engineering discipline, courses are framed in the vertical stack of the CDIO framework and all the courses are implemented through active learning strategies (Cherney, 2018; Prince, 2004; Lin, 2017). This article focuses on the impact of ALS on the 18IT320 – Object Oriented Programming (OOP) course offered to graduates of the III Semester – IT (Information Technology) students. This course consists of 5 Course Outcomes (CO) with different weightage. The details about COs are given in Table 2 of Section 3.1. The outcome of the OOP course is measured in terms of CO attainment, course exit survey and test result performances. By following the implementation of ALS and an ICT tool-based teaching environment, there is the potential for significant improvements in attainment (Budu, 2019).

The remaining section of the paper is structured as follows: Section 2 addresses the relevant work; Section 3 explains the methodology used for the overall assessment process; Section 4 discusses the findings and debates and makes various distinctions by comparing two batch results; and Section 5 concludes the paper.

2. Related Work

A key aspect of collaborative learning is the development of a pleasant, supportive, non-threatening and encouraging learning environment. With the aid of this learning environment, students can freely engage and participate in a comfortable learning process.

The goal of the Active Learning Approach is to improve the enjoyable learning nature of students and to engage them with knowledge (Magana, 2018; Altrichter, 2017). Practicing this ALS method in a classroom setting will provide a real sense of the actual learning process. Applying this to programming courses like C++ and JAVA can motivate students to perform at a much higher level. In an active learning process, learners may also be inspired to imitate similar work and learning circumstances on their own. Some of the popular and most effective active learning strategies (ALS) and Information and Communication Technology (ICT) tools that are used to improve the performance of teaching and learning are discussed in this section. ALS include Think pair share (TPS), Problem-based learning, Quick write & Peer editing, Group discussion, Jigsaws, Polling, quiz, Posters, gallery or video assignments, Fish bowl etc., (Cherney, 2018; Varma-Nelson, 2020; Prince, 2004).

In think pair share approach, learners need to act instead of passively listening. It is an easy technique for active learning that contributes to collaboration. Learners must plan individually, express their views with peers, consider peer responses, and then summarize the subject in the most successful manner. The outcome of this approach would encourage learners to structure their ideas first on their own, then in a smaller group before sharing with the entire group (Rajivlochan, 2017). Problem-based learning strategy [2] leads the student groups to focus on a problem over a fixed period of time, requiring them to understand the problem and start suggesting a answer or solution. The small groups identified can do the first round of research and report back simultaneously, identify

stakeholders and report back at the same time.

Peer teaching is also referred to as tutoring, and is another successful form of teaching newly enrolled student, such as first year undergraduate students and direct second years (Diploma holders gaining UG admission via lateral entry schemes). It is beneficial for students to learn new ideas (Varma-Nelson, 2020). Another method is Quick Write in which students are given a limited amount of time to write down their ideas, thoughts, or comments regarding a topic. This activity could be used to see if pupils have finished their homework or assignments. It gives students the opportunity to recall their prior knowledge of the subject. Quick writing activity may be graded to inspire students to do their reading assignment. Peer editing guides students to study each other's written work. Peers ought to express specific standards instead of merely asking students to read and analyze writing (Varma-Nelson, 2020; Lin, 2017). Flipped classroom technique is one of the growing teaching learning pedagogies that makes productive use of class time, improves one-on-one focus and creates student accountability (Silva, 2018).

Group discussion is a dynamic activity that encourage the students to think critically. It is defined as an activity in which a group of students meets face to face and openly express their views in order to reach a decision on a topic. (Powell, 2017). The jigsaw technique splits problems into small pieces and assigns them to groups. Each student in the group reads one part of the material and then shares the information with the rest of their group. Each student will be assigned a different concept to read on a common theme. Then everyone will present the idea to the community in preparation for the synthesis of all the articles.

There are different tools and applications like clickers, PollEverywhere.com, Socrative.com, etc., can be used for polling in which the students can vote anonymously on what they perceive as the best explanation to a question. The quizzes can be done in two ways, the individual and the group quizzes. After the individual quiz, the students will be placed into small groups immediately, and they will have to take the same quiz again, except this time they will have to discuss the answers in their group. Quizzes may be graded and, if the group score is higher, the two grades are averaged (Borch, 2020).

Pausing in lecture strategy works as follows: Introduce a waiting period during the lecture for students to focus on the subject. Do the conversation and apply the ideas that have just been discussed and allow them to take an active part in the lecture instead of taking notes passively. Group of students need to work together and present their ideas on a chart sheet of paper, or make them available as videos or animations and it can be considered as Posters, Gallery & Video assignments in ALS (Kuosa, 2016). When students have completed their poster or video, it has to be demonstrated clearly to all of the learners in a poster session.

A fish bowl approach makes it possible for a select group of students to participate in a discussion of

Table 1: List of ICT Tools

S.No	ICT Tools
1.	LCD Smart classes
2.	Smart interactive Boards
3.	Padlet
4.	Clickers and Plickers
5.	PDAs
6.	Google Class room
7.	Google Forms
8.	Google Drive
9.	Moodles
10.	CANVAS
11.	EDMODO
12.	GNOMIO
13.	Schoology
14.	Slido
15.	Class Marker
16.	Podcast
17.	Github
18.	Screen castify
19.	Web Applications
20.	Group Emails
21.	Video Streaming
22.	Mobile Learning Apps

topics that have alternative responses while the majority of the students listen and take notes (Powell, 2017). All the students sit in the outer circle and watch the debate of a select group of students in the inner circle.

Information Communication Technology (ICT) tools contribute to a high-quality understanding of content, because they have the potential to increase student motivation, link students to a wide range of learning opportunities, promote active in-campus and out-campus learning environments, and enable teachers to facilitate the course more times (Zuber, 2018).

The use of ICT tools in the teaching and learning process is also the best way for many educators to teach. The various ICT tools used for effective teaching are shown in Table 1. These technologies increase student self-confidence and self-esteem to learn (Kocak, 2016). In general, new technologies encourage self-directed and active learning that makes the students more responsible for their own learning. To implement ALS environment for the teaching learning process various ICT tools and Learning Management Systems (LMS) can be utilized. Apart from the tools listed in the table 1, various webinar series, YouTube Channels, Khan academy, Customized individual sites, IIT Bombay Platforms like BodhiLab and Spoken Tutorial, Skype, GMeet for online video meetings, materials from in-house lecture capturing and streaming systems, etc., are also the eminent ICT platforms for the student learners (Guo, 2018; Silva, 2018; Drissi, 2016). Massive Open Online Courses (MOOCs) promotes the equality in learning opportunities to all kind of students (Costa, 2018; Tadjer, 2018). This will enable them to learn and interact with the forum of students, professors, international trainers with feedback, quizzes and assignments.

Online or social media-based programming activities allow students to work anywhere and submit assignments at any time. It also improves students ' reflective thinking by getting immediate feedback. The key benefit of using online courses in programming subject is, the student can practice the code by learning – by – doing approach (Guo, 2018). Students would have a stronger understanding, perform better on the tests, and remain more engaged with the material throughout the lecture when they are given partial, rather than complete, notes or PowerPoints. These advances help students develop a capacity that allows them to accumulate social, cognitive, emotional and behavioural skills to achieve learning objectives.

3. Methodology

The Object-Oriented Programming (OOP) curriculum has been framed on the basis of a successful educational framework called CDIO, which promotes learning experience related to personal, interpersonal, product, process and system building skills. In the CDIO approach, students receive high-level education in the form of conceiving, planning, implementing and operating real-world programmes. This can be achieved through the use of constructive learning resources and problem-based learning in classrooms. Students have already finished a CDIO-based Lateral Thinking course in their second semester, so they will have no trouble in coping with this OOP subject.

The OOP course curriculum design has been benchmarked with leading higher learning institutions in abroad and with few Indian Institute of Technology (IITs) and National Institute of Technology (NITs). The framed curriculum with higher Bloom's level is then approved by the board of study members consisting of academic and industry staff (Budu, 2019). During the campus learning, many of the active learning strategies, such as Think-Pair-Share, Roll Play, Peer Learning, Quiz and Mini Projects were added to the OOP course and outcome-based assessments were performed. Class environment set up was conveniently facilitated for student interaction during the active learning

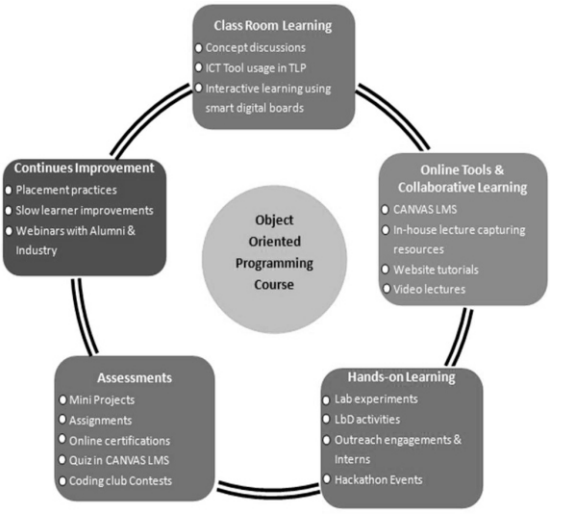

Fig. 1: Overall Evaluation Process of Object Oriented Programming Course.

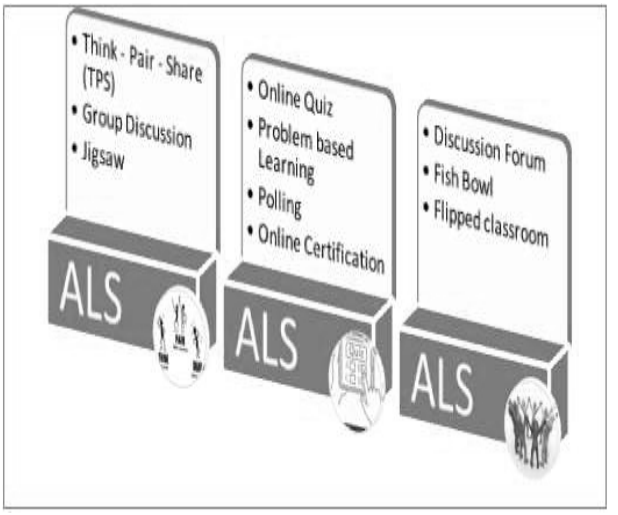

Fig. 2: ALS practiced for Object Oriented Programming course.

practices. Fig.1. illustrates the overall evaluation process of OOP course. Various active learning practices followed throughout the semester for the course is shown in Fig. 2.

A. Class Room Learning

In order to create a learner-centric learning process, the traditional classroom set up is transformed into a relaxed, non-threatening atmosphere during concept-based classroom discussions. Students are encouraged to ask questions through the online discussion forum. The programming concepts were discussed, demonstrated using the modern digital ICT technologies which includes a computer, LCD Projector with screen and a smart digital board for the different types of content delivery and interactive learning purposes. All live classroom sessions focused on active learning have been captured in lecture capturing systems and the same is made available to students for further reference and enhancement. The above strategies shall be used to cover the course outcome (CO) of the OOP course which is shown in Table 2.

Table 2: Course outcome along with its weightage

CO Number	Course Outcome Statement	Weightage in %
CO1	Make use of programming concepts like Control structures, looping statements, type casting and I/O file operations for solving the given problem.	16
CO2	Construct object -oriented programs for the given scenario using object - oriented concepts like abstraction, encapsulation, polymorphism and inheritance.	17
CO3	Apply package, interface and exception handling mechanism for the given problem.	17
CO4	Implement multithread concepts for the real-world scenario.	16
CO5	Develop object-oriented applications for the given scenario that uses events through swing, collections and logging	34

B. Online Tools and Collaborative Learning

The ICT and online tools give the effective way of teaching learning process in terms of active and collaborative learning (shown in Fig 3). All the course materials can be posted by the faculty in Online Learning Management system (LMS) such as Canvas, gnomio, and google class rooms.

Fig. 3 : Collaborative Learning.

The authors used Canvas LMS for the teaching learning process and conducted online assessment through quiz, group assignment and discussion forum, etc. Learners can access the course material from anywhere at any time. Video lectures from the faculty, links to online tutorials and daily sessions recorded by in-house learning systems are made accessible to students in order to create a collaborative learning atmosphere.

C. Hands on Learning

A hand on practical lab experiments plays a central role in learning programming courses. The theory course is having “object-oriented programming lab” in parallel. This hands-on practice using the program editors such as Jcreator, Netbeans, and Eclipse enhances the students in mastering the subject, increases the understanding of the fundamental and complex concepts and will be more helpful in achieving the course outcomes.

Fig. 4: Hands - on Learning.

Learning by Doing (LbD) or hands-on practice helps the students to observe and understand how the program works. This will motivate the beginners to do programming individually and to do group assignments as well. It encourages the students to develop their personal and leadership skills. During the lab practices, students are asked to create a team with a size of 3 and the team has to identify and choose any society relevant problems to be solved using OOP concepts. The lab has a total of 12 experiments. Laboratory experiments were evaluated not only on the basis of the output made, but also on the basis of quiz and viva questions. Fig. 4 corresponds to the outcome of hands-on learning, i.e., the students are participated in one of the world's largest event, Smart India Hackathon, organized by Government of India.

D. Assessments

The performance of students in each registered course shall be measured for a maximum of 100 marks. The continuous evaluation is carried out three times during the semester and the terminal test is carried out at the end of the semester. This continuous assessment tests will be consolidated to 50 marks while the terminal examination also rounded of to 50 marks. The continuous assessment marks can be calculated as follows: 40 marks from best two of three test performance and 10 marks from three assignment submissions.

Apart from the usual continuous assessment and terminal examinations, the students were assessed through few outcome-based assessments as listed,

· Mini Project implementation on many real-world problems is given to every team size of three students to strengthen their understanding of the programming fundamentals and it has been considered as one of the graded activities.

Fig. 5 : Online Quiz.

· As part of course of the study, graded group assignments and individual assignments were given to the students to assess their understanding on the complex programming concepts taught.

· All the students were directed to appear for the Spoken tutorial online certification course on Java programming. Spoken tutorial is an initiative by MHRD of Indian government, developed by IIT Bombay.

Conducting programming quizzes as shown in Fig. 5, increases student interaction in a special way and introduces students to the learning process even without the teacher. The LMS enables the instructors to randomize the quiz questions in a single click and the results of the quiz can be evaluated immediately upon completion.

E. Continuous Improvement activity

Based on initial evaluation results and student participation, top-level students are provided with technical guidance to crack their complex programming logics in placements by practicing them in hackathons and hacker rank challenges.

This will significantly enhance the student's performance in complex programming and analytical skills. In order to increase interest on the subject, a few webinars have been presented by alumni and industrial experts on advanced programming principles and topics beyond the syllabuses.

The slow learners have also been identified and necessary mentoring steps including peer learning, special coaching classes has been arranged to improve

the level of engagement and success in the course. During the practical session, the slow learners are merged with medium and fast learners. This helps to improve their project management skills, learning skills, leadership skills and communication skills.

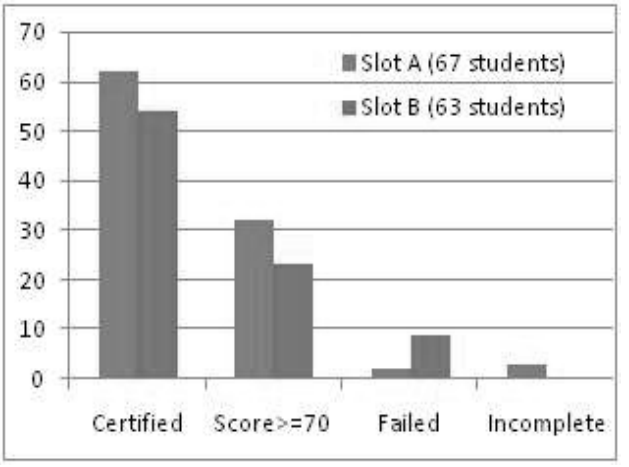

Fig. 6: IIT Bombay spoken tutorial online certification exam.

F. Coding Club Engagements

Coding club at the departmental level is a phenomenal working force with congenial mentors. Coding club has the network of best coding members with in-depth programming abilities and straightforward to logic. The students can assess themselves by participating on the contests and they can know about the other good coders in the department. They can also get reference from coding club alumni members via video meetings. Since students share a common learning management system, they feel a sense of common learning, a sense of sharing and interacting rather than isolation or remoteness. As an outcome of this, few students went to intern to the nearby software companies during the semester holidays and engaged with projects along with the trained programmers, which in turn leads to the "earn while learn" option.

4. Results And Discussion

The outcomes of the course were reached to the fullest extent possible as students were able to present their innovative concepts, business strategies and solutions to the societal challenges in their mini-project presentations. At the beginning of the course, students were not aware of the importance of programming, but at the end of the course they developed a strong knowledge base and coding skills on OOP concepts. The effect was seen as we were handling the course and the lab session for the same group of students in their higher semesters.

The student success was assessed through a variety of activities, such as participation in the online certification offered by IIT Bombay's spoken tutorial, as illustrated in Fig. 6. Discussion forum participation as represented in Fig. 7., and attending online quiz as shown in Fig. 8., The online quiz sample is also shown in Fig 9.

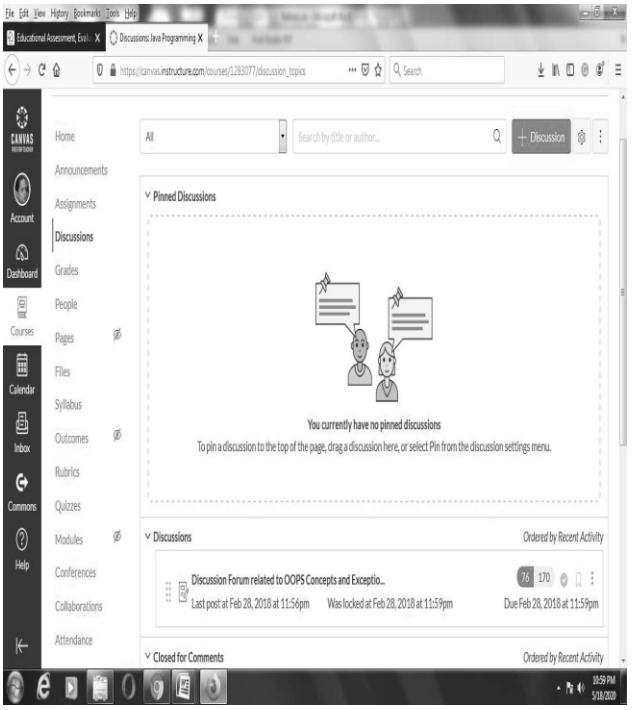

Fig. 7: Student's involvement in Discussion Forum – Canvas LMS

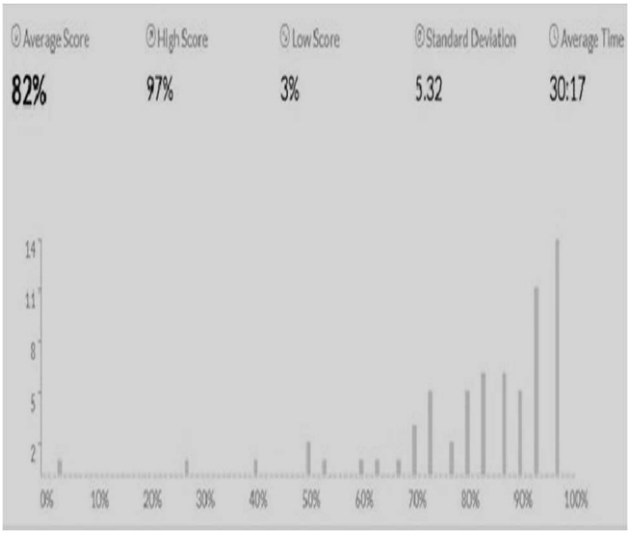

Fig. 8: Summary of Quiz conducted in LMS.

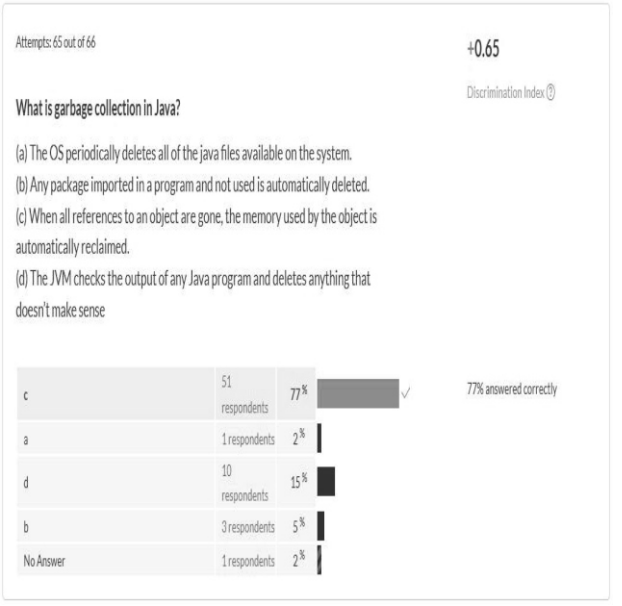

Fig. 9: Quiz in LMS - Question Breakdown sample.

The outcomes of the course were measured based on Expected Proficiency (EP) and Expected Level of Attainment (ELA). EP and ELA of all the courses are fixed based on the average performance in end semester examinations for the respective set of students graduated in the academic years 2014-2015, 2015-2016 and 2016-2017 respectively. For fixing the expected level of proficiency, 30% improvement is considered from the current level of attainment. Based on the above calculation, EP has been set to B and 70% has been set to ELA for the OOP course. EP and ELA are calculated for all the courses and the same is used as a target for course attainment calculations for students graduated in the academic years 2017-2018, 2018-19, 2019-20 etc., CO attainment calculation has done for the individual CO's based on internal test performance, end semester performance, course exit survey and assignments. In overall CO attainment calculation 30% weightage was allotted to internal test, 60% was allotted to end semester test and 10 % allotted to course exit survey. 90% weightage is given to direct attainment calculation and 10% weightage is given into indirect attainment calculation.

The detailed normalized CO attainment for the OOP course is shown in Fig 10 – Fig 15. The individual description of the CO is shown in Table 2. The detailed assessment process is given in section 3.4. CO attainment of internal assessment and external assessment is shown in Fig. 10 and Fig. 11. In the internal assessment, the first three CO attainments are less than 70% whereas as the attainment of CO4 and CO5 is greater than 90. Less than 70% indicates that, initially students struggled with writing the code, though they understood the concepts well. Through slow learner's process, collaborative learning and peer coaching, the attainment improvement was made in CO4 and CO5. In the external assessment, the attainments of the entire COs are greater than 90%. The inference from the external assessment is,

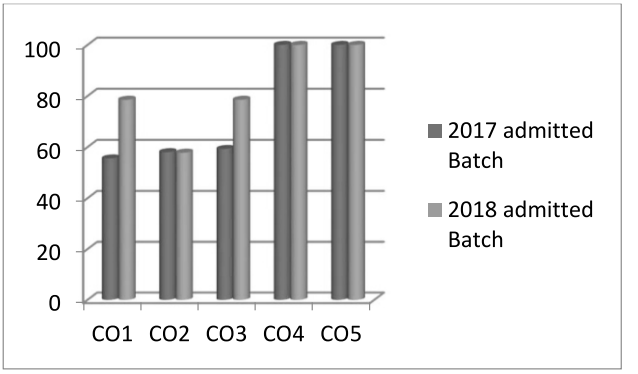

Fig. 10: CO attainment calculation based on internal Assessment.

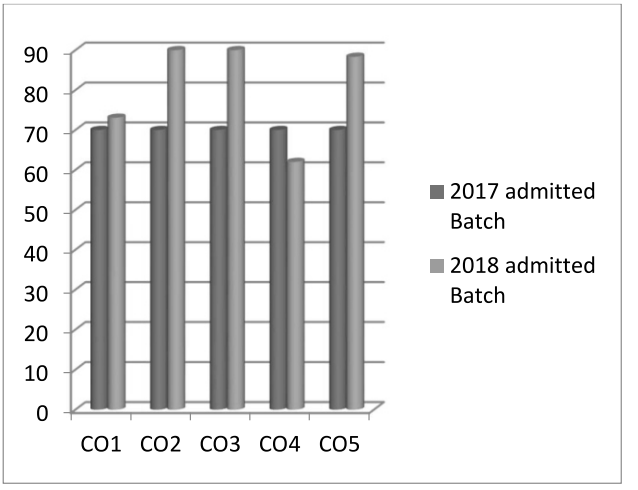

Fig. 11: CO attainment calculation based on end semester assessment.

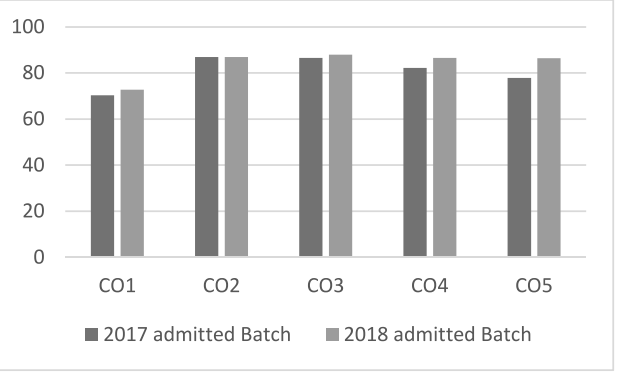

Fig. 12: CO attainment based on course exit survey.

students performed well in end semester even though they struggled during internal tests. However, some of the students struggled in the concepts like File I/O operations and threading.

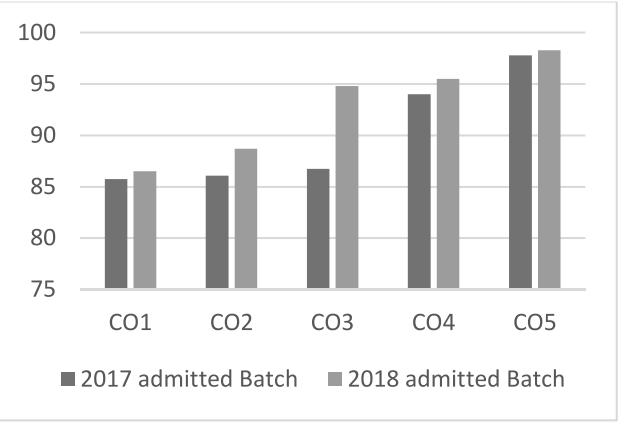

Fig. 13: Overall CO attainment calculation.

Fig. 12 shows that indirect CO attainment based on course exit survey. The average percentage of exit survey is 82% for 2018 admitted batch. Whereas, the average percentage of exit survey is 83% for 2017 admitted batch. The overall CO attainment for the two batches is shown in Fig. 13. Due to the implementation of ALS and ICT tools usage, the attainments of the entire COs are improved in great extent.

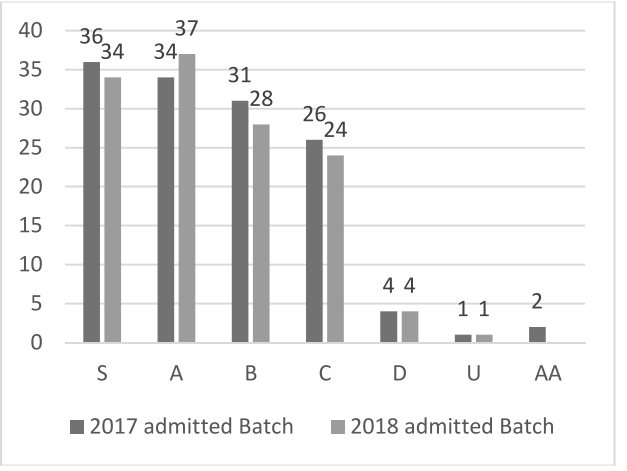

Fig. 14: Result performance of theory course.

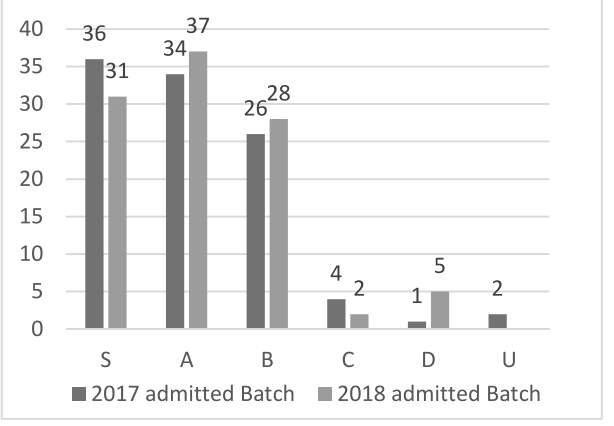

Fig. 15: Result performance of Lab course.

The result performance of the two batches in terms of grades is shown in Fig. 14 and Fig. 15. The interpretation of the results is as follows: S grade (>=90), A grade (> = 80 and < 89) , B grade (> = 70 and < 79) , C grade (> = 60 and < 69) , D grade (> = 50 and < 59) , U grade (<50) and AA (Absent). The results other than U and AA indicate that students cleared the exam. LOA means student didn't admitted to appear for the final examinations due to lag in attendance. Students who got LOA have to reappear for the course and will earn attendance. In both the batches, very less number of students failed in theory courses. In the lab courses, the failure count for 2017 admitted batch is 1 and for 2018 admitted batch is 0. The outcome implies that the failure count not only depends on ALS and ICT tool usage, it also depends on student's interest and coding practices towards improving the learning skills and knowledge.

Students with good coding skills participated in and received awards at international and national events like ResFest' 19 conducted by FPT University, Vietnam, Hackathon events, Hacker ranking competition, Kaggle competition etc. Some of the students have also completed internships with renowned companies such as Amazon, Ericsson, and Honeywell, etc.

5. Conclusion

Active learning strategies can turn classrooms into constructive and shared learning environments when implemented effectively with ICT resources. This research study shows and suggests that active learning pedagogy has positive outcomes compared to the traditional approach. Implementation of the ALS is not difficult and not time-consuming to produce positive student learning outcomes and achievements. Active learning should be seen as an integral approach to teaching not only for programming subjects but also in the entire higher education system as much as possible to meet the demands put on students during their college careers, at the workplace and in the wider context of life. Creating an active learning environment and an ICT environment will show

significant results in student's performance within a short duration as presented in the article. In the future, we hope to create and carry out an assessment system that can reliably test engineering reasoning, problem-solving, and logical thinking across programming languages.

References

[1] Altrichter, H., & Gamsjäger, M. (2017). A conceptual model for research in performance standard policies. Nordic Journal of Studies in Educational Policy, 3(1), 6–20. doi:10.1080/20020317.2017.1316180.

[2] Borch, I., Sandvoll, R. & Risør, T. (2020). Discrepancies in purposes of student course evaluations: what does It mean to be "satisfied"?. Educ Asse Eval Acc, 32, 83–102. https://doi.org/10.1007/s11092-020 09315-x.

[3] Budu, J. (2019). Higher-Order Learning Outcomes in an Undergraduate IT Project Management Course. International Journal of Information and Communication Technology Education (IJICTE), 15(4), 1-11. doi:10.4018/IJICTE.2019100101.

[4] Cherney, I. D. (2008). The effects of active learning on students' memories for course content. Active Learning in Higher Education, 9(2), 152–171. https://doi.org/10.1177/1469787408090841.

[5] Costa, C., Teixeira, L., & Alvelos, H. (2018). Exploring the Usage of MOOCs in Higher Education Institutions: Characterization of the Most Used Platforms. International Journal of Information and Communication Technology Education (IJICTE), 14(4), 1-17. doi:10.4018/IJICTE.2018100101.

[6] Drissi, S., & Amirat, A. (2016). An Adaptive E-Learning System based on Student's Learning Styles: An Empirical Study. International Journal of Distance Education Technologies (IJDET), 14(3), 34-51. doi:10.4018/IJDET.2016070103.

[7] Guo, R., Shen, Y., & Li, L. (2018). Using Social Media to Improve Student-Instructor Communication in an Online Learning Environment. International Journal of Information and Communication Technology Education (IJICTE), 14(1), 33-43. doi:10.4018/IJICTE.2018010103.

[8] Kocak, Ö., Yıldırım, Ö., Kurşun, E., & Yıldırım, G. (2016). Investigating the Status of Tablet Computers and E-Books Use of Open Education Faculty Students: A Case Study. International Journal of Distance Education Technologies (IJDET), 14(2), 49-63. doi:10.4018/IJDET.2016040104.

[9] Kuosa, K., Distante, D., Tervakari, A., Cerulo, L., Fernández, A., Koro, J., & Kailanto, M. (2016). Interactive Visualization Tools to Improve Learning and Teaching in Online Learning Environments. International Journal of Distance Education Technologies (IJDET), 14(1), 1-21. doi:10.4018/IJDET.2016010101.

[10] Lin, Y., Chen, M., Chang, C., & Chang, P. (2017). Exploring the Peer Interaction Effects on Learning Achievement in a Social Learning Platform Based on Social Network Analysis. International Journal of Distance Education Technologies (IJDET), 15(3), 65-85. doi:10.4018/IJDET.2017070105.

[11] Magana, A. J., Vieira, C., & Boutin, M. (2018). Characterizing Engineering Learners' Preferences for Active and Passive Learning Methods. IEEE Transactions on Education, 61(1), 46–54. doi:10.1109/te.2017.2740203.

[12] Prince, M. (2004). Does Active Learning Work? A Review of the Research. Journal of Engineering Education, 93(3), 223–231. doi:10.1002/j.2168-9830.2004.tb00809.x.

[13] Powell, L. M., Wimmer, H., Kilgus, L., & Force, C. M. (2017). Impact of Online Discussions on Web Based Assessments. International Journal of Distance Education Technologies (IJDET), 15(4), 99-111. doi:10.4018/IJDET.2017100106.

[14] R Rajivlochan, M., & Rajivlochan, M. (2018). Choice-Based Credit System (CBCS) and Semester System in Indian Higher Education. India Higher Education Report 2017: Teaching, Learning and Quality in Higher Education,

233–252. doi:10.4135/9789353280338.n10.

[15] Silva, J. C., Zambom, E., Rodrigues, R. L., Ramos, J. L., & de Souza, F. D. (2018). Effects of Learning Analytics on Students' Self-Regulated Learning in Flipped Classroom. International Journal of Information and Communication Technology Education (IJICTE), 14(3), 91-107. doi:10.4018/IJICTE.2018070108

[16] Tadjer, H., Lafifi, Y., & Seridi-Bouchelaghem, H. (2018). A New Approach for Assessing Learners in an Online Problem Based Learning Environment. International Journal of Information and Communication Technology Education (IJICTE), 14(4), 18-33. doi:10.4018/IJICTE.2018100102

[17] Varma-Nelson, P., & Cracolice, M. S. (2020). Peer-Led Team Learning. Active Learning in College Science, 205–218. doi:10.1007/978-3-030-33600-4_14.

[18] Zuber, J., Altrichter, H. (2018) The role of teacher characteristics in an educational standards reform. Educ AsseEval Acc 30, 183–205. https://doi.org/10.1007/s11092-018-9275-7.