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Enriching and Energizing the Virtual Classroom using Breakout Sessions: A better experience of Active Learning during Covid-19 Pandemic.

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***Abstract*—** The Covid-19 pandemic has impacted educational institutes all over the World. As teachers and students adapt to the new normal, Zoom, Google meet, Microsoft teams, or Cisco WebEx have become the most sought-after platforms for distance learning. The challenge for teachers and students in online learning is active peer engagement. To encourage problem-based learning, online platforms allow the creation of breakout rooms. Breakout rooms are private chat rooms where small groups of 3-4 students discuss unique problem statements allocated to them and employ peer learning methods through interpersonal communication. Teachers or facilitators enrich the knowledge of the students in active learning sessions. This research paper dives deep into the benefits, drawbacks, and implications of breakout rooms in E-learning environments. It is a collective case study on the use of breakout rooms by students and facilitators at an elite engineering college in Maharashtra, India. The first-hand experience of undergraduate Computer Science students and their Database Management Systems teacher is being considered. Student recommendations on use of breakout rooms have been consolidated at the end of this paper. Through our analysis and encouraging statistics, we wish to advocate the use of breakout rooms to engage students, in online learning platforms.

***Keywords*—** Active Learning; Breakout Rooms; Computer Science (CS); Database Management System (DBMS); E-learning; Peer Learning.

***JEET Category*— Research**

I. INTRODUCTION

THE PANDEMIC forced India into a lockdown in March 2020. Since then, educational institutes through their grit and determination rose to the challenge by adopting various online platforms for their discourses [1]. Technological advancements in videoconferencing platforms and E-learning sites helped educational establishments enrich and energize the online learning experience for their students [2]. Teachers delivered lectures using basic features like screen sharing in a common (main) room to all attendees. Students asked queries by using the 'raise hand' icon, putting messages in the chat box, or by unmuting themselves. The challenge with such a pedagogy was the lack of active student interaction. Not all students were able to dynamically participate in the lectures. They were unable to share their screens and explain their ideas to the teachers, especially in practical implementation sessions.

Breakout rooms in Cisco WebEx, Zoom, and other leading platforms, allow the main session to be split into approximately 50 concurrent sessions. Breakout rooms are used for collaboration and discussion in the meeting. Using these rooms, problem-based learning is implemented by facilitators. They encourage active learning by using think-pair-share [3] and its various other counterparts. The host (facilitator) has control over student placement, session time limit, and students switching between rooms. Teachers can assess and give feedback through emojis on student work to motivate them. Breakout rooms allow students to communicate freely in a language of their preference, share the screen, discuss ideas, annotate shared screens and use the whiteboard to solve a given problem statement. Each room of 3-4 students is separate from the main session so participants relax and enjoy working with their peer group. They can provide necessary feedback on their peer's work. Every room of participants is independent of each other. Scintillating conversations and constructive criticism energize the atmosphere in breakout rooms. Students can connect with peers and teachers, while maintaining social distance.

Through our research, we wish to encourage facilitators to use breakout rooms, quizzes, poll questions, and more to keep the students engaged during the lecture.

II. RELATED WORK

Taylor et. al [4] in their New York Times article lay emphasis on the resilience of students. Students and facilitators have accepted that the pandemic is unprecedented and they have adapted to new online platforms quickly. Their study accentuates the simplicity, security, and ease of using breakout rooms in virtual classes. Facilitators use innovative teaching methods, video calls, fun quizzes, and other peer learning events to ensure active student participation. Students learn from colleagues and retain valuable information for years.

Lougheed and his colleagues (2012) [5] highlight the dearth of breakout room usage in postsecondary education. They report that published literature consolidates the feedback or impact of learning in breakout rooms but not features of the application in itself. They urge that research must focus on the pedagogical elements of breakout rooms that assist active learning, such as ask for help icon and move into another room.

Brown et al. (2016) [6] advocate synchronous, web-based

learning to encourage student interaction. There is a paucity of research on benefits to facilitators in using online breakout rooms. There is limited focus on viability and methodology of implementation of breakout rooms for peer learning. While the authors encourage the use of breakout rooms, not enough light is shed on creating breakout rooms and time duration during which students interact with their facilitators or peers.

Martin and Parker (2014) [7] in their research believe in developing a sense of community and active learning through breakout rooms. They examine the demographics to emphasis why synchronous learning is ideal, however, examination of impact of breakout rooms, based on a particular subject or content type is absent.

Ellingson and Notbohm (2012) [8] discuss the technical aspects of breakout room creation, features and use. They recognize breakout rooms as integral elements of active learning, but do not provide any guidelines for effective usage or research on impact of the room in student development.

Cadieux, et. al [9] have studied the impact of use of breakout rooms to train medical students with no prior training. They used a 60-minute virtual meeting of the Medical Education Journal Club (MEJC) to monitor around 15 participants. During the discussion, all students are put into breakout rooms, in groups of 3. In the absence of preparation, students perform active learning tasks with their peers. At the end of stipulated time, a quiz is given to the students to monitor progress. 13/15 or 87% students successfully completed the quiz, which was an all-time maximum result for the club. Participant's feedback show that breakout rooms are comfortable, convenient and interactive. They help develop good discussions and creative ideas.

III. METHODOLOGY

We are documenting the virtual learning experience of students studying Database Management System (DBMS) on WebEx and Zoom platforms. In the absence of physical face-to-face meetings, students benefit from peer learning in breakout rooms. They use breakout rooms for practical implementation of design and implementation of databases. DBMS is a problem-solving based subject. Design of databases can have several viewpoints and there is no single right answer. This case study emphasizes the impact of breakout rooms in such scenarios. Multiple brainstorming sessions, peer assessment and collaborative learning enable students to develop different viewpoints of design. They learn to prioritize requirements, simplify design and think innovatively. We hope to motivate facilitators to use breakout rooms for online learning in this pandemic, as they clear the fundamentals of the students. The detailed strategy map we implemented to realize our goals are enlisted as follows:

1. Introduce the topic and background to the students, along with metrics for evaluation (if any). Emphasize the importance of peer discussions and expectations of the task.
2. Create breakout rooms and randomly assign students to each room or allow students to select a room of their choice. Random allocation is beneficial to new associations in a virtual environment while familiar faces encourage students to engage in formal debate and collaborative thought process.
3. The facilitator can move between rooms to view the informal proceedings. Students may call for help and the facilitator can resolve any issues or queries in the room itself.
4. The teacher can dissociate groups by asking students to return to the main room or ending the time allocated to the breakout room. Once peers finalize ideas through critical thinking in breakout rooms, they are encouraged to share their learnings with the class in the main room or the facilitator can choose to highlight commendable points of the group efforts. Facilitators can take this opportunity to identify common mistakes, crucial pointers and pointers for all the students.

This cumulative study monitors the progress of undergraduate Computer Science students in the age group of 19-21 years, over the course of 3 months. They are studying DBMS under an Assistant Professor with over 10 years of teaching experience. Their learnings, challenges and suggestions have been collected anonymously through Google forms. Statistics consolidated at the end of this paper aim to reinforce the benefits of using breakout rooms.

IV. BENEFITS OF BREAKOUT ROOMS

During online learning, a common room does not cater to the knowledge needs of all students, as everyone has different paces of learning. Thus, breakout rooms with small groups of students help level the learning curve for all students, promoting active learning among their peers. The facets and gains of using breakout rooms for peer learning have been enlisted below.

A. Hands on Experience

In DBMS practical sessions, a group of 3-4 students implements the theory learnt and can see what errors come when commands are executed in MySQL. For example: In theory, a database table must have single primary key and should be defined only once. Primary key can be added to the table during creation of the table or after columns are created. Addition of primary and foreign keys after table creation is a good programming practice, as it improves readability of the script. Students who face difficulties in understanding fundamental concepts in theory class, are able to clarify it through practical application. Students are encouraged to implement academic concepts in a myriad of ways, thus developing multiple perspectives to problem solving.

B. Collaborative Learning

Students who study collaboratively learn swiftly, retain facts, comprehend information and develop their mental faculties [10]. For the subject DBMS, students facing difficulties in command execution or problem understanding can switch to their peer's breakout room. They can see how others are implementing the assignment. Students are inspired to try the same, or improve existing solutions. Their peers help resolve

simple issues like syntax errors (SELECT * FROM employee instead of SELECT * FROM employee;) and spelling errors (INTIGIR instead of INTEGER) in commands. Some complex problems like using a foreign key, before its declaration cause an error. It engages all the students' and facilitator's help.

Breakout rooms enable teachers to switch into the rooms when called for help by the students. Collaboration enables students to develop a good rapport with their facilitators. Predominantly, in online learning, teaching is from the facilitator's end. Breakout rooms enable teachers to listen to student inputs. Facilitators help streamline student discussions and iron out incongruities to reach a final solution that adheres to the assignment specifications. Active learning promotes facilitators and students to develop new perspectives to the assigned challenge.

C. Student Interaction

Student attitudes play an important role in peer interactions [11]. Breakout rooms make the best use of the informal communication to develop student psychology and social skills. Breakout rooms in online platforms allow facilitators to assign students to a room or allow students to choose their rooms. This encourages students, who are unable to meet each other due to the pandemic, to make new friends or virtually meet old ones. Shy students speak up and bold students implement out of the box ideas. Ones facing network issues during the theory class are found to be most active in breakout rooms. In breakout sessions, morale is high during peer learning. All students communicate to learn different design and implementation approaches to the given task. Students develop interpersonal skills and question why someone uses a command, instead of simpler ones. For example, IN command checks if a value lies in a certain range. Majority of the students use greater than (>) and less than (<) symbols to check for range. They later implemented the simpler IN and BETWEEN commands. Students actively volunteer to share their screens and talk about what they see or can do to solve the problem easily. They encourage their peers by reacting with emojis to good work and use breakout room features to annotate errors. Thus, everyone develops creative thinking and a deep understanding, through problem-based learning.

D. Facilitator Role

The influence of a good teacher is irreplaceable. They are instrumental in facilitating and pointing learners in the right direction [14]. In the virtual mode, facilitators may use breakout rooms to provide clear instructions, create rooms, solve queries, allow student movement from 1 room to another and evaluate solutions. Often teachers rotate the problem statements amongst various groups, to ensure all groups get a new statement to work on, during every breakout session. The facilitator can take screenshots of shared screens and ask students to return to the main room for an informed discussion. All students and teachers work collectively to acquire knowledge about problem at hand. Breakout rooms not only reduce the vocal strain of teachers, but also decrease time needed for rapport building between teachers and students. Breakout rooms have a smaller number of students in a room, so the facilitator can assess students immediately. Students work closely with their teacher in breakout rooms and agree that they enjoyed the active learning experience immensely. To sum up, the facilitators can suggest design improvements, provide guidelines on how to improve scripting and help develop good programming practices, for their course. Consider the following instance of the subject DBMS: Some students create the database schema with all columns first. Later, they use ALTER command to label PRIMARY and FOREIGN keys. This is a good programming practice that helps readers of the code identify errors quickly.

E. Ask for Help

In breakout rooms, the 'Ask for help' button is provided that students use when they need their facilitator's advice or help. This helps teachers understand the students' approach to the assignment, the common mistakes students make and areas where more practice is needed. In the subject DBMS, when breakout sessions were introduced for the first time, students were apprehensive. They often used 'ask for help' only from the facilitator. As sessions progressed, they became more comfortable with peer learning and asked their peers for help. For example: Entity Relationship Diagram (ERD) to logical schema conversion was tough for the students. Most were confused about cardinality and participation constraints. The facilitator allocated 3-4 unique problem statements to every breakout room. Students drew ERD diagrams in rooms with their peers and reconvened in the main session. All diagram features and mistakes were addressed in great detail, in the main session. Thus, active peer learning helped students develop better results in the future practical sessions.

F. Active Learning

Knowledge is the collection of information, while intelligence is the ability to apply knowledge. The power of many people thinking compared to a single idea is easily visible in breakout rooms. Students dynamically participate in discussions in small groups and develop intelligent solutions to every problem statement. Active participation, brainstorming and inquisitiveness of students helps development of multiple ideas. The facilitator simply refines crude ideas, while students develop viable solutions in a wholesome learning environment.

TABLE I
STRENGTHS OF BREAKOUT ROOMS

Factors	Breakout Rooms	Theory Session
Even learning field	In a breakout room, students who think similarly work together. They help each other learn. Students who are lagging can be helped by their peers. Due to small, cohesive groups, students get undivided attention. They collaborate to bring everyone to the same level of understanding.	In a theory class, the teacher has to cater to students who learn quickly as well as some slow learners. They employ an average teaching speed. Thus, not all students are at the same level of understanding as the others. Some may be on to advanced concepts, while others may need more practice.

Screen sharing	Students can share their screens and see what their peer is doing. Dynamic peer learning occurs.	Students cannot share their screens, so they listen to the teacher. Some take notes, but most of the learning is passive.
Practical execution	Students can implement what they have learnt in the theory sessions. They can solve their doubts through trial-and-error techniques. If they face difficulty, they can move to a peer's breakout room or ask the facilitator to resolve their queries.	Practical implementation is limited. With many students asking doubts at once, it is difficult for the teacher to explain the concept to everyone. Thus, breakout sessions can be helpful.
Individual attention	Teachers can move from 1 room to another and see how students are approaching the problem. Individuals can approach the facilitator for private tutorials or coaching sessions, in a breakout room.	In a class with a large no. of students, say 50-100, facilitators find it tough to decide if the student has grasped the concepts. Not all student queries can be answered in theory sessions.
Gauge progress	Breakout rooms have a time limit of around 15-20 minutes. Most students finish the problem within time, but some require more time. The facilitator can perform assessments and encourage students who are lagging to work better.	Online theory classroom settings do not give an accurate measure of everyone's learning capabilities. Some have understood the concept, but they are unable to convey it to the teacher.
Problem based learning	Breakout rooms allow students to ask facilitators for tips. They can also switch rooms to ask peers for help. Often seeing another approach to the problem can guide students. Students think well when they have an idea of what is expected.	Theory sessions do not allow students to see what their peers are doing, so they cannot ask each other for help.

V. RESULTS AND DISCUSSION

DBMS is a core engineering subject for Computer Science (CS). It encourages problem-based or active learning approach to design and implementation of databases. Online theory sessions teach students necessary concepts, but practise develops confidence. Students can use practical sessions to implement these concepts. In this research case study, we have recorded the responses of third year, undergraduate CS engineering students. We have studied their feedback of using breakout rooms for hands-on experience with Structured Query Language (SQL) queries.

Facilitators can create and run as many free Google forms as needed, through their personal Google account. They have control over student access to form, collation of various responses and viewing the statistics generated [13]. In this study, barring language and cultural differences, all students have similar socio-economic conditions. They are studying in an online environment and have had same impact of the pandemic.

In the following diagrams, we have explained the statistics of their responses to the Google form questionnaire. All responses are unbiased and anonymous. Through this analysis we hope to encourage facilitators to use breakout rooms for engaging online active learning.

Hypothesis: Breakout rooms do not impact active learning in online platforms. They are cumbersome to manage and students prefer theory lectures to breakout rooms.

Questions:

- Are breakouts rooms helpful to the subject (DBMS)
- Does moving into a peer's room benefit learning
- Is error discussion in main room beneficial
- Active Learning in breakout rooms
- Impact of time on peer learning learners in e-learning.

Fig. 1 Breakout rooms for Database Management System learning sessions

Fig.1 shows 40% participants strongly agree that breakout rooms help them understand DBMS well. 40% students agree while 15% are neutral towards this question. A small fraction of 5% students is dissatisfied with the results of breakout rooms. These students faced technical difficulties, such as intermittent connection, voice lag, frozen screen and delay in joining a room. Therefore, they were unable to participate in breakout sessions. They were not able to contribute fruitfully to the discussions. However, upon when they fixed these technical issues, they enjoyed interacting with their peers in DBMS practicals. In conclusion, 80% of students agree that breakout rooms were helpful for the subject – Database Management Systems.

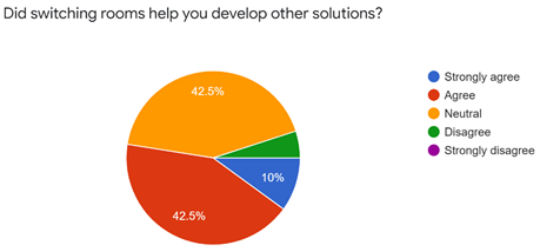

Fig. 2 Switching between breakout rooms to learn from peers

Breakout rooms are virtual chat spaces, isolated from the main room. Facilitators can move from 1 room to another. Often students wish to ask their friends for help and request their facilitator to send them into a specific room. Recent discoveries indicate the presence of 'mirror' neurons in the prefrontal cortex of the human brain [14]. Upon seeing someone do something, similar neurons are fired in the viewer's eyes. They 'grasp' the concept by visualizing the needful and implement the same. Today, these mirror neurons enable babies to emulate their parents and students to learn concepts from their peers. More often than naught, students teach themselves in

fascinating ways. Facilitators in breakout rooms simply allow students to move into their friends' room, so they learn the concept. Fig. 2 is following this theory of mirror learning. It shows that 42.5% students agree with the idea that peers help them learn. They can apply the logic of 'monkey see-monkey do' to their problem statements [15].

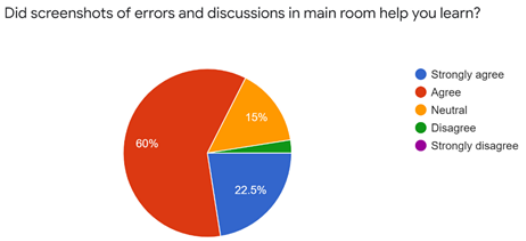

Fig. 3 Doubt clarifications in breakout rooms

In traditional classroom settings, 'correct' responses are praised while 'incorrect' responses are ignored [16]. Deviant answers are disregarded and different approaches are modified to conform to the general solution. Praise or contempt often deviate from the problem at hand. The expectation to excel or the fear of failure does not empower students to critically think, evaluate and reconsider possible solutions. Such inconsistences have to be addressed in a meaningful way, especially to engineers of tomorrow. E-learning platforms allow the facilitator to move among all breakout rooms to view progress of all participants. They can take screenshots of shared screens. After the breakout session time expires, students re-join the main room. Screenshots of student's scripting practices and syntax are shared by the facilitator and discussions on improvement of the solution are held. As seen in fig. 3, 60% students agree that this constructive criticism helps them improve their understanding of the subject. They are motivated to improve and do better in the next breakout session. 22.5% students have a growth mindset and believe error discussion is necessary for concept development. 15% students are neutral and 2.5% students, with a fixed mindset disagree. They feel that their responses did not fit the procedure being exercised, hence must not be discussed.

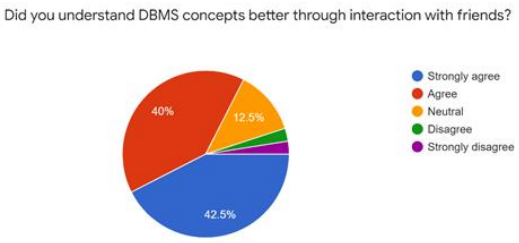

Fig. 4 Active Learning using breakout rooms

Practice makes perfect and collaborative learning helps students greatly. Fig. 4 depicts that majority of the students (42.5%) strongly agree that they are able to develop their concepts through breakout rooms. 40% students agree that discussions with peers helps them gain a good understanding of the problem. Their friends catch their mistakes early, enabling them to complete better work in the stipulated time. Peer learning boosts their confidence and piques scientific curiosity in DBMS tasks. 12.5% students are neutral to peer support. 'Too many cooks can spoil the broth', is evident by the 2.5% students who disagree or 2.5% who strongly disagree with this question. Their peers give too many suggestions or do not motivate their hard work. Therefore, a minor fraction of students finds breakout room sessions futile. They advocate theory understanding is sufficient to comprehend the subject.

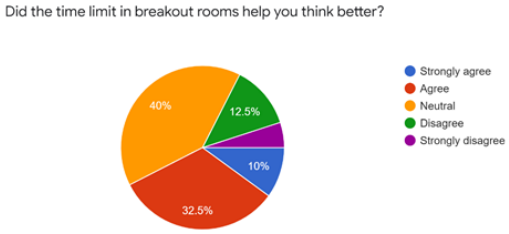

Fig. 5 Time limit in breakout rooms

Students and facilitators acknowledge the stress created when they have to perform well in breakout rooms. Various research studies explain the impact of stress on learning and memory [17]. Pressure to accomplish certain tasks, in given time leads to development of robust memories, but impairs instantaneous memory retrieval. In the heat of the moment, students fail to recollect facts and study material. Under dire stress, they improvise by integrating new information into existing, malleable memory. It is only later, after the stress has passed do students realize what they had implemented and why. Thus, stress induced changes hamper the students' abilities to work well in the moment, but ensures long term learning. Fig. 5 illustrates that only 32.5% of students agree that the pressure to perform in a stipulated time frame, helps them. These students did prerequisite work from home, such as populating the database with data before the commencement of sessions. This enables them to spend more time on query execution. 40% of students express neutral sentiment towards the time constraint in a breakout room, while 12.5% of students state that the time limit does not help them think. It forces them to show results that are not up to the mark, as they feel rushed. For future use of breakout rooms, we believe it would be beneficial to introduce an average time constraint that will aid all students.

VI. CONCLUSION

Thus, this collective research case study demonstrates the positive impact of breakout rooms in various facets. Using breakout rooms students can freely communicate, collaborate and learn. Peer interaction, learning, and error checking are improved through such sessions. Facilitators can look into breakout sessions as a means for one-on-one communication and dynamic problem-based learning, where students help themselves.

We aim to support the consensus on breakout rooms. They are an innovative and engaging environment conducive to learning. Breakout rooms are a good way to break up the monotony of watching a screen or listening to a teacher. They give students a chance to establish closer connections with each other, in a virtual environment. They engross themselves in collaborative work and build momentum for discussion in the central room. In this paper, the importance of online learning and the strengths of breakout rooms are discussed in depth. We hope this research and analysis can assist facilitators in understanding and utilizing the best features of online

platforms. We encourage facilitators to use technological advancements in online videoconferencing platforms, for successful student participation in problem-based learning.

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