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Learning Analytics: Gamification in Flipped Classroom for Higher Education

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Abstract: The Flipped classroom is an innovative pedagogical model that has been adopted in various colleges across different disciplines. The Flipped classroom allows the students to actively participate and collaborate during in-class activities. The measure of learner's performance, cognitive skills, and behaviour is essential in any teaching-learning process to assess and improvise the curriculum, syllabus, learning methodology, and educational technology. In this research work, various innovative teaching models suitable for Gen Z learners have been experimented with. These models included a virtual classroom, laboratory sessions, and flipped classrooms that were compared with the traditional classroom approach. A new model "CAM-S" is proposed to measure the Cognitive, Affective, and Motivational traits and identify slow learners. Learning analytics using the K-Means clustering algorithm is performed to analyze the behaviour and learning patterns of the learners in these pedagogical models. From the clusters obtained, the students were categorized into 3 different groups based on their performances. The result obtained after the analysis shows that Flipped Classroom has better learner performances when compared with the other pedagogical methodologies. Additionally, separate questionnaires are also created to obtain feedback from the students about their experiences with the 3 pedagogical techniques used. Even the behavioural models are analyzed using the gaming environment in the flipped classroom.

Keywords: Blended Learning, Clustering algorithm, Flipped Classroom, Gamification, Learning Analytics.

1. Introduction

The flipped classroom (Priyaadharshini M and Vinayaga Sundaram B,2018) is considered to be a popular teaching methodology in recent years in schools and higher education. The students of the 21st century demand innovative pedagogical models (Silva, A. S et al., 2022) by using Information and Communication Technology (ICT).

The flipped classroom is considered to be (Busaya Santikarn and Saovapa Wichadee, 2018) an effective teaching model for various departments of engineering students. The flipped classroom flips the traditional approach and motivates the students to actively participate in classroom activities. In the flipped classroom, the course instructors upload the learning contents in any format of PowerPoint presentation, word, video, audio files, etc usually one or two days before the lecture. These online contents (Naik, A. S et al., 2022) may also be combined with interactive quizzes to engage the students. The

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students are provided with the guidelines of the flipped classroom model before the classroom sessions and reminded about the process so that the learners do not skip the flipped classroom sessions. The in-class lecture periods are incorporated with collaborating activities based on the out-class subject. The flipped classroom demands students (Chanakan Sojayapan, and Jintavee Khlaisang, 2018) active participation during out-class and in-class activities which acts as a catalyst for the self-motivation of the learner.

The flipped classroom approach is adopted with a variety of classroom activities based on the courses. The components (Eichler, J. F.,2022) and the activities of the flipped classroom are decided by the course instructor by considering the cognitive level of the students. The instructional design for the out-class sessions is planned by the faculty based on the topic and their teaching style. The course contents may include audio, video, or simulation-based content each with a 10 to 15-minute duration. The flipped classroom can also be adapted to inculcate other learning methodologies like problem-based learning (Oliveira, H. et al., 2022), collaborative learning (Yildiz Durak, H., 2022), blended learning, and game-based learning (Lopes, S. F., & Simões, J. M. D. A. P., 2022). These strategies will be an added advantage for the course instructor to teach and evaluate the learners based on the learners' behaviour.

The flipped classroom places responsibility on the instructors to organize and plan for the in-class activities and out-class (Liu, D., & Zhang, H., 2022) learning contents. The proper planning and strategies adopted for the flipped classroom will add more quality and benefits for both learners and course instructors. Various approaches and activities have been experimented with in flipped classrooms namely problem-based learning, blended learning, experimental learning, game-based learning, etc.

Gamification (Khairul Anhar Holder, N. A et al.,2022) represents the game design features in a non-game context to motivate people and solve problems. This definition also helps to differentiate "gamification" from "serious games" and "full-fledged games". Game design components are the essential blocks of games and features that play a crucial role in the gaming environment. Game-based learning is a popular tactic (Gulsum Asksoy, 2018) to encourage the learner's motivation and involve active learning. Even gaming platforms are quite popular as a hobby and it is implemented in the educational environment to help the course instructors maintain a balance between the objectives and student expectations. Much current research works involve gamification concepts to highly motivate learners and act as a catalyst to enhance self-learning skills for better performances.

Game-based learning (de Carvalho, C. V., & Coelho, A., 2022) has had an optimistic effect on student's performance and motivation for learning over a decade. Gamification's impact on student motivation and performance is an important topic, as there has been increased interest in gamification at the college level. The design and delivery of a gaming platform must be developed to attract the attention of all learners and engage them in active participation. Various types of gaming environments (Odikpo, C., 2022) can be used for education. However, the challenging factor for the course instructor is to plan for a suitable one matching the course outcomes. Many game-based learning environments are not suitable for higher education since it is explored only at the school level. Hence, it is adopting a game and strategy is essential to satisfy undergraduate engineering students. Game-based learning is a pedagogical model suitable for students ranging from high achievers to slow learners.

The performances of the learners (Yildirim, D., & Gülbahar, Y., 2022) are improved and it is considered a beneficial technique to be sandwiched along with a traditional classroom. The students are sometimes demotivated to attend all the courses in the same conventional classroom style for all the topics. Hence, game-based learning can motivate learners when a few interactive sessions are conducted as a part of the course. The learners are motivated (Aksoy, B., & Pasli Gurdogan, E., 2022) to attend flipped classrooms which gives an opportunity to develop self-learning (Zhiru Sun et al., 2018), self-determination using out-class activity, and active, collaborative, peer-peer learning using in-class activities.

Learning analytics techniques (Sarmiento, J. P., & Wise, A. F., 2022) are used to collect the data, measure, and analyze the learners' performances. It helps to track the learner's behaviour and analyze the results for a high-quality education system. The learning analytics techniques are relevant for the educational platform to process the collected data of the students and analyze it by using suitable data mining or statistical algorithms in a distributed

environment. Learning analytics are capable of processing a large volume of data and analyzing the learners' performance and behavioural model.

In this study, the flipped classroom is explored to implement the benefits of a gaming platform for engineering courses (Díaz-Ramírez, J., 2020). The behavioural models are analyzed using the gaming environment in the flipped classroom. Other digital learning techniques like the virtual classroom and flipped classroom (Salshabella, D. C. et al., 2022) are compared with the traditional class in terms of performances in behavioural models, motivation, and identifying the slow learners in these strategies. In game-based learning, the in-class activity is transformed into game-based learning. The measure of the learner's performance, knowledge, and behaviour (Yen-Ting Lin, 2019) is essential in any teaching-learning process to evaluate and improvise the curriculum, syllabus, learning methodology, and educational technology. The game-based learning resulted in positive and better performances in terms of grades acquired by the students and resulted in active participation in the learning process.

2. Literature Survey

The research performed (Biyun Huang & Khe Foon,2018) explores gamification that motivated the learners to engage in out-class activities. Five motivation metrics are proposed, namely goal-access-feedback-challenge-collaboration. (GAFCC) for the gamification design model (Sabri, Z. et al., 2022) strategy is incorporated using two quasi-experimental studies for postgraduate students. The learner's feedback is collected through interviews and studies. The result shows that the GAFCC model is effective for higher completion rates and quality activities in flipped classrooms. A study (by Maria Espada et al., 2020) focused on flipped classrooms with 'learning to learn' competency in the university context. This approach was adopted for traditional and flipped classroom strategies with before and after impact (Isaiah T et al., 2019) studies. It is observed that this approach did not result in any significant differences between flipped and conventional teaching strategies.

The flipped classroom with gamification approach (Yang, K. C., & Kang, Y., 2022) is experimented with for analyzing the effect of gamification in flipped classrooms. The intrinsic motivation traits are enhanced towards goal achievement. To measure these metrics, the author conducted a questionnaire for foreign English languages using the gamification approach. This research insisted on well-designed components of game-based learning with user tasks, user interfaces, and feedback.

The objective of the study (Hasan Huseyin Ozer et al., 2018) is to measure the teacher's perspectives of learners' attitudes towards project development courses using a game-based flipped classroom. Both quantitative and qualitative techniques are experimented with, in this study for about 14 weeks. In the qualitative metrics, pre-test and post-test were conducted to measure the learners' attitudes towards coding behaviour (Li, M. et al., 2022). In the quantitative measure, an interview was conducted to measure in-depth information. This analysis shows that the teachers were more satisfied with the game-based flipped classroom (Durrani, U. et al., 2022) approach. It also enhanced the motivation level during in-class activities.

This research work experiments with the learner's perceptions of the flipped classroom (Yeh, Y. C., 2022) in research methods. The analysis involved a questionnaire given to the students (n = 240) to determine their perceptions of the flipped classroom. The course video was considered a learning tool in Moodle LMS (Yoo, J. E. et al.,2022) (Learning Management System). The result shows that the majority of the learners had a positive impact on the flipped classroom pedagogical model. It also represents a strong correlation with the student's motivation, engagement, and enhanced learning behaviour. This research work also has a positive impact and effective learning strategy for the low achievers when compared to high achievers in the class.

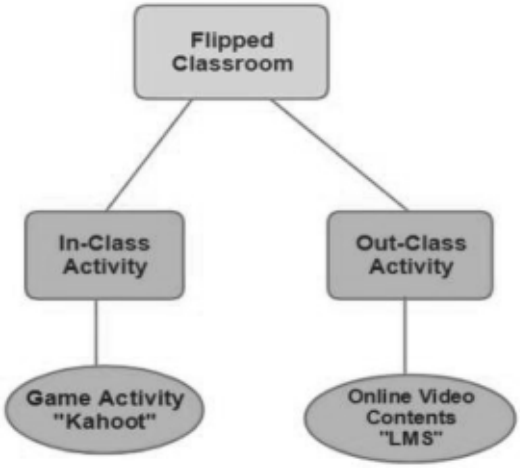

Fig. 1: Architecture for Game-based Learning

3. Proposed Architecture

In this study, the flipped classroom sessions are planned for the B.Tech undergraduate students for the virtualization course. 142 students participated in the flipped classroom using game-based learning. The proposed flipped classroom session architecture for game-based learning is represented in Fig. 1. The instructor uploads the course contents in Moodle LMS in video, audio, and PDF file format. The students take responsibility to learn the out-class topic and appear for the classroom sessions. During in-class sessions, each student participates in the game-based learning sessions which are based on the out-class contents. During the in-class activity, the learners actively participated in game-based learning and the positive stimulus (Jaaska, E., & Aaltonen, K., 2022) was absorbed by the learners.

The online game-based quiz called Kahoot was used in the in-class activity as given in Fig. 2. The Kahoot (Wirani, Y et al., 2022) is a game-based learning platform for schools and higher education that uses ICT for education. The flipped classroom sessions were conducted in the classroom and students used their mobile/laptop to attend the game-based learning sessions using Kahoot. However, a device with a proper data connection is essential to attend the quiz questions.

Fig. 2 : Kahoot Quiz

The quiz questions are projected on the whiteboard (Zhang, S., 2022) by the instructor, and scores are given for each correct answer which is bounded by timer interval. The topic from the virtualization course was conducted as flipped classroom sessions. Totally five sessions were conducted for this particular course and the flipped classroom link was added in Moodle.

The Kahoot displays the correct answer for each question along with the scoreboard leadership for top score achievers in each quiz. The students were excited to see their scores on the board and it motivated them to answer all the questions in the quiz without skipping them. The flipped classroom sessions with game-based learning allowed the learners for blended and active learning (Nirgude, M. et al., 2022) with self-determination which inspires the students to participate in this game-based flipped classroom pedagogical model.

A. Traditional Classroom

In the traditional classroom, the learners attend the classroom lecture for the virtualization courses and the lecture hour includes 3-hour sessions per week. The faculty delivers the in-class lecture and trains the learners to acquire knowledge in a particular course. The instructor's objective also holds to improve the cognitive level and make the learners achieve the learning outcome as per ABET (Abu-Eisheh, S. A., & Ghanim, M. S.,2022) accreditation. However, traditional classroom sessions are always considered to be a teacher-centred approach. The students are a dearth of active learning and collaborative learning (Carvalho, A. R., & Santos, C.,2022) skills in the traditional classroom. Since the traditional classroom session adopts the same teaching strategy for all the topics in the courses, the learners feel monotony and lose interest in classroom lectures. For the traditional classroom, the course contents are uploaded in Moodle (Tan, X. et al., 2021) as represented in Fig. 3. The students are assessed based on the marks scored in the two assessment marks CAT 1 and CAT 2 for the virtualization course.

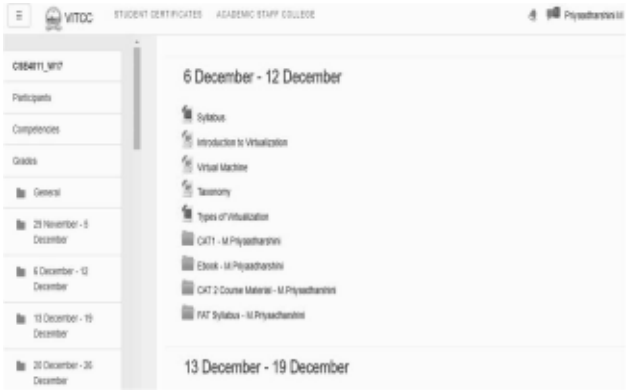

Fig. 3. Traditional Classroom

B. Virtual Classroom

The virtualization course was conducted in a virtual classroom for three sessions in a semester. The virtual classroom involves the student attending the lecture hour virtually without attending the classroom sessions. Both students and teachers are connected

virtually by using open-source tools available for video conferencing (Lobe, B., & Morgan, D. L., 2021). The Bigbluebutton is a web conferencing add-on tool available in Moodle which connects students and teachers through collaborative learning.

The virtual classroom session timing is informed to all the students which enables them to be available live in Moodle Bigbluebutton activity. The students showed more interest in attending virtual classroom sessions and the queries are addressed through public chat available in the Bigbluebutton (Voloshynov, S. A., & Yurzhenko, A. Y., 2021). These video recordings are available all the time and can be viewed in the LMS anytime by the learners. After the virtual classroom sessions, the teacher uploads the higher-order thinking (HOTs) questions in Moodle. The students solve these questions and submit them in the same portal for the evaluation process.

4. Cam-s Model

In this analysis, three innovative teaching techniques namely traditional classroom, virtual classroom, and flipped classroom are conducted after the evaluation of CAT 1. Each of these teaching methodologies was adopted for the virtualization course of the B.Tech program and the impact of these methodologies was measured and analyzed. The proposed model CAM-S is abbreviated as Cognitive, Affective, Motivation, and Slow learners. The objective of the CAM-S model is to measure the behavioural attributes (Sharma, S. et al.,2021) like cognitive, affective, intrinsic, and extrinsic motivations and identify slow learners (Ahshan, R., 2021) in these teaching methodologies for undergraduate courses. The overall scope of this research work using the CAM-S model is given in Fig. 4.

Innovative teaching techniques like the virtual classroom, and flipped classroom, are analyzed and compared with the traditional classroom in terms of overall performance. The student's performances are assessed and evaluated using CAT 1 exams. The marks scored in this assessment enable the faculty to understand the cognitive level of the students (Lwande, C. et al., 2021). After CAT 1, the students are clustered based on their performance in the CAT 1 assessment. As per the CAM-S model, the following strategies are used to determine the cognitive, affective, motivational, and slow learners.

A. C-Cognitive Model

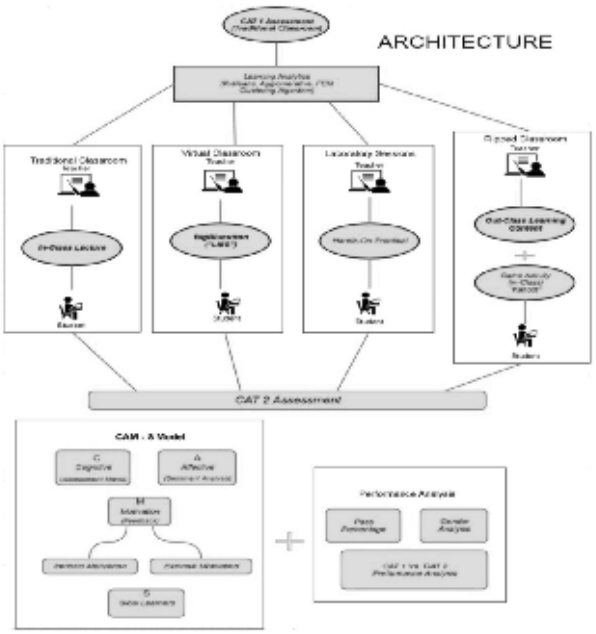

Fig. 4 : CAM-S Model

The cognitive-behavioural model determines the knowledge or thinking level of the students. The act of self-learning (Blackmore, C et al., 2021) also enhances cognitive skills in a constructive way throughout the courses. The cognitive skill helps the course instructor to understand the level of the students and deliver the course contents based on their skills and knowledge. In this research work, the cognitive knowledge acquired by the students using the flipped classroom, and virtual classroom techniques are measured to identify the suitable teaching technique for the learners. The CAT 2 marks are considered a metric to measure the cognitive skills of the learners. The CAT 2 assessment marks of these techniques are compared with the traditional approach with CAT 1 assessment marks.

B. A-Affective Behaviour

The affective behavioural model denotes the learner's emotions or attitudes towards an activity or task (Camacho-Morles, J. et al., 2021). The affective attitude in education is influenced or affected by various factors like personal, social, and psychological issues. The learner's performances are also influenced by the affective behaviour at all levels of learners in higher education (Mona Lundin et al., 2018). Hence, the measure of affective factors plays a vital role in education. The understanding of affective behaviour will help the course instructors to improve

the performance of the learners with metacognitive and, self-efficacy strategies (Taghani, A., & Razavi, M. R., 2021). The feedback given by the students after adopting the traditional classroom flipped classroom, and virtual classroom is collected in this research work. This feedback allowed recognising the affective behaviour for various pedagogical techniques. The Sentiment analysis is used to automatically identify the opinion and emotions from the student's feedback. The sentiment analysis (Bulusu, A., & Rao, K. R., 2021) determines the positive, negative, and neutral emotions for the virtualization course.

C.M-Motivation Model

Motivation is a catalyst to make the students involved in the academic process and gain knowledge, skills, and achievements. It is essential for higher education as students are stressed by involving in many academic activities during their college life. Hence, the motivation level of the students should be determined for a particular course. Thereby, the teaching strategies can be modified based on interest and emotions. Motivation is measured based on two categories called intrinsic and extrinsic motivation. Internal motivation refers to the learner's participation in an activity with pleasure, fun, interest, and enjoyment. Extrinsic motivation refers to external motivating factors such as grades, rewards, and competition or evaluation for participating in the activities. It is essential to measure the intrinsic and extrinsic motivation of the learners as it has an impact on the pedagogical models adopted in classroom teaching. The level of intrinsic and extrinsic motivation varies for each learner and it influences the outcome or performance of the learners in academic activities.

In this research work, intrinsic motivation is measured based on the active participation or attendance of the learners in all the pedagogical models. This intrinsic motivation reveals the interest to get accustomed to these education technology models. Extrinsic motivation is measured based on the student's feedback. Extrinsic motivation is used to identify the curiosity of the learner's participation in the activities, and any influence on the marks, rewards, or punishment.

D. S-Slow Learners

Slow learners face difficulty in acquiring knowledge and reproducing the information during the assessment or assignment. The slow learners are focused with extra attention by the teacher, which enables them to develop skills and expected competency in the course. Slow learners can be trained in their learning style pattern which can yield a better cognitive level with active participation in the class. Before giving importance to the slow learners with various strategies, identification of slow learners is essential for any course. The slow learners can be identified using the assessment, assignment marks, and their level of active involvement or participation in classroom activities. In this research work, identifying the slow learners is also considered one of the objectives of the proposed model CAM-S, where "S" denotes analysis related to the slow learners. The slow learners are identified in all the educational methodologies like the flipped classroom, traditional classroom, and virtual classroom based on the CAT 1 and CAT 2 assessment marks.

5. Learning Analytics For CAM-s Model

The clustering algorithm brings effective results to group the learners based on the observed patterns. Each student will be categorized into several groups with the learner belonging to many clusters that target different perceptions. It analyzes the distance between the clusters as a mechanism to guide the students towards better performance. The effectiveness of the cohesive peer groups among the clusters and within the student group can be analyzed. The traditional algorithms can handle only numerical data and are not available to offer solutions for learning analytics solutions.

The clustering algorithm used for this analysis is the K-Means clustering algorithm (Fahim, A., 2020). The clusters are created based on the CAT 1 assessment marks. These clusters categorize the students into various groups with expert, average, and slow learner levels. The cluster group also determines the performance of the learners for the first assessment in a course. Before the conduct of the second assessment (CAT 2), the innovative teaching-learning process is adopted for the learners, and the performance of these pedagogical models is also clustered and categorized to determine the level of the learners. This cluster will help the facilitator to identify the high achievers and slow learners in the class. This also aids to measure the impact of adopted teaching techniques on CAT 2 assessment.

The focuses of this research work on various

analyses using CAM-S are listed below:

1. Identify the levels of the learners using clustering algorithms based on CAT 1 assessment marks and compare them with CAT 2 marks.

2. The measure of cognitive behaviour for the virtual classroom, flipped classroom, and traditional classroom.

3. The affective behaviour of learners is identified using sentiment analysis along with feedback from the learners.

4. The intrinsic and extrinsic motivations for all the techniques are measured.

5. Identify the slow learners for the traditional classroom, virtual classroom, and flipped classroom pedagogical models.

A. Data collection:

The dataset considered in this research comprises the assessment scores of 142 undergraduate students from a virtualization course. The collective assessment score was obtained via CAT 1 and CAT 2 (Continuous Assessment Tests 1 and 2) conducted through 3 different teaching methodologies namely the traditional approach, the virtual classroom and the flipped classroom method. The score of CAT 1 is taken through a traditional teaching approach whereas the marks of CAT 2 are taken from the virtual and flipped classroom methodology.

Post-data collection cluster analysis is performed on the student's performance to segregate them into 3 different categories namely expert learners, average ones and slow learners. An unsupervised learning algorithm namely K-Means clustering is chosen to group the students with homogeneous characteristics into similar clusters.

B. Cluster Analysis

The clusters are created based on the CAT 1 and CAT 2 assessment marks of the traditional classroom approach and this helps the course instructor to identify the level of the students. The three clusters are created as group 0, group 1, and group 2 which are categorized as expert, average and slow learners (represented in blue, green and red colour) respectively. The CAT 1 performances (traditional approach) are compared with the CAT 2 assessment marks using K-Means clustering algorithms as given in Fig. 5.

C. Cognitive Behaviour

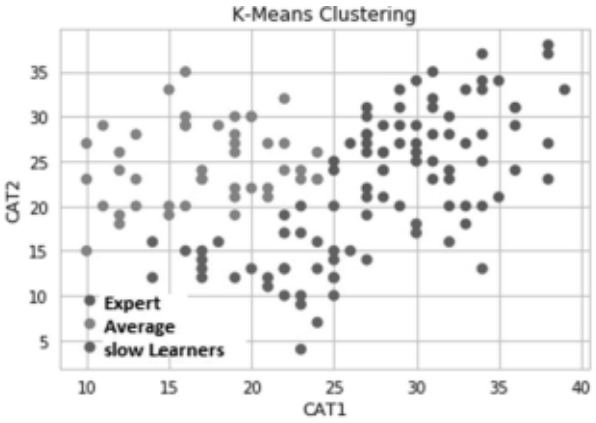

Fig. 5 : K-Means Clustering Algorithm

The cognitive behaviour of the students is identified in the CAM-S model for the virtual classroom, flipped classroom teaching methodologies. The cognitive behaviour of virtual classrooms using the K-Means clustering algorithm based on CAT 2 performances is given in Fig. 6. It shows that very few slow learners are categorized in group 2 (red colour). The overall results show that cognitive behaviour is improved and the number of high achievers and average students is high and this reflects innovative educational methodologies have an impact on CAT 2 performances of the learners.

Fig. 7. represents the cognitive behaviour for the flipped classroom using the K-Means clustering algorithm. The high achievers and average marks are

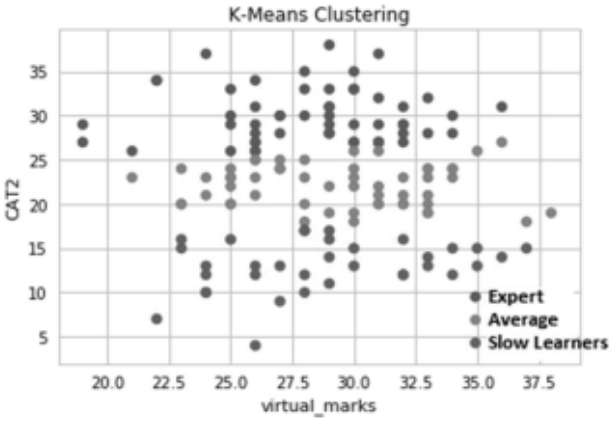

Fig. 6 : Cognitive Behavior – Virtual Classroom - K-Means Clustering Algorithm

to slow learners i.e group 0 and group 1 given in blue and green colour have more students than group 2 represented in red.

The Heat Map is given in Fig. 8. to correlate the relationship between all the educational methodologies with the two assessment marks

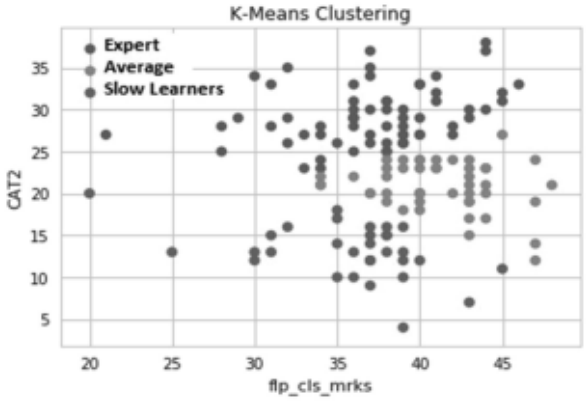

Fig. 7. : Cognitive Behavior – Flipped Classroom - K-Means Clustering Algorithm

observed from the traditional classroom. The heat map reveals the correlation does exist for all the techniques. The value ranging from 0 to 1 suggests the correlation between the techniques. The value '0' will reflect the models are not correlated and value 1 represents the correlation relationship.

D. Affective Behaviour using Sentiment Analysis

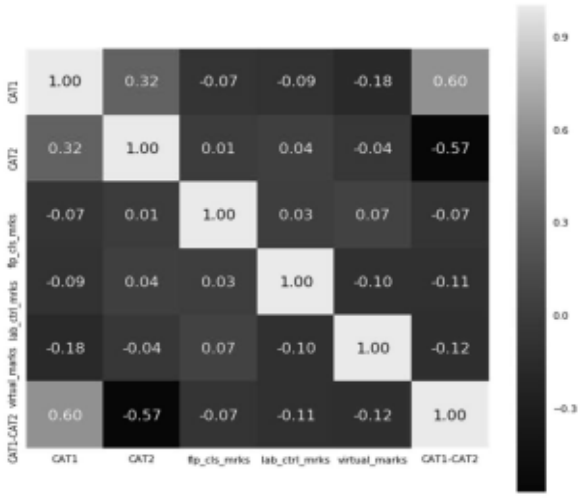

Fig. 8 : Heat Map

The affective behaviour is identified by collecting feedback about the student's opinions on the various education methodologies like the traditional classroom, virtual classroom, and flipped classroom. The total number of students who participated was 75 and their feedback is collected in google forms. The opinion about individual techniques is submitted by the students to assess their emotions or ideas about the course using sentiment analysis. It represents the positive and negative emotions toward the virtualization course. Fig. 9. represents the number of opinions collected was 474 with 71 as positive emotions, 28 as negative emotions, and 375 giving an opinion for the traditional approach as neutral.

The sentiment analysis of the traditional classroom

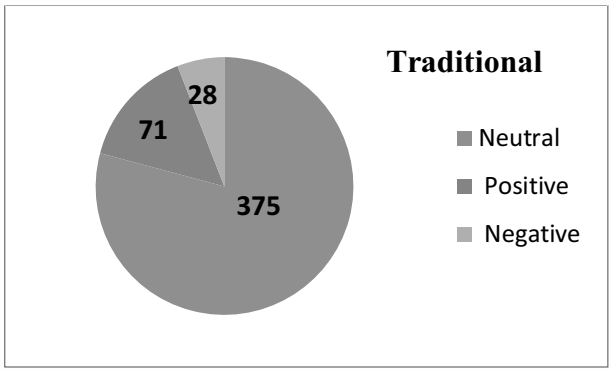

Fig. 9: Student's Opinion - Traditional Classroom

is given in Fig. 10.

Fig. 10 : Sentiment Analysis - Traditional Classroom

Totally 463 opinions are collected for the virtual classroom with 71 positive emotions, 4 negative opinions, and 388 neutral opinions as given in Fig. 11.

The sentiment analysis for the virtual classroom is shown in Fig. 12. The positive emotions for the virtual classroom are the same as the traditional classroom approach.

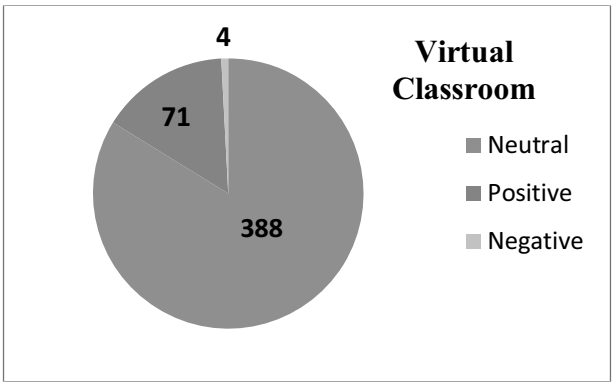

Fig. 11 : Student's Opinion – Virtual Classroom

Fig. 12 : Sentiment Analysis – Virtual Classroom

Fig. 13 represents the 408 responses with 99

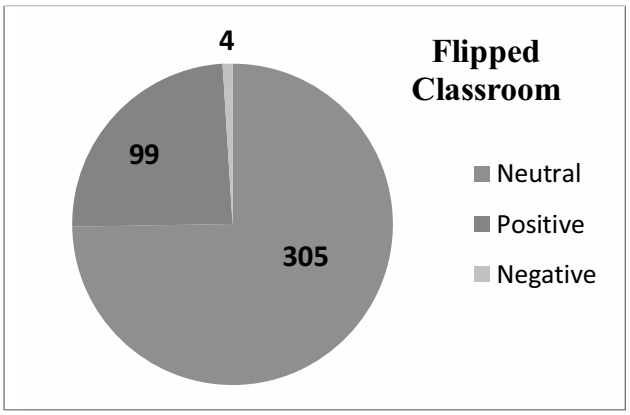

Fig. 13. Students Opinion – Flipped Classroom

positive responses, 4 negative responses, and 305 neutral emotions.

The sentiment analyses for flipped classroom experiences are given in Fig. 14. The flipped

Fig. 14 : Sentiment Analysis – Flipped Classroom

classroom got better responses and positive emotions when compared with all other techniques.

The game-based learning in the flipped classroom has gained all the attention and interest to participate in the teaching-learning process. Fig. 15. shows the

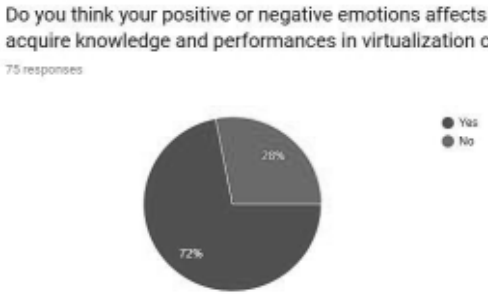

Fig. 15: Affective Behavior Feedback

feedback based on the student's emotions, 72% of students agreed that positive or negative emotions on the course affect their overall performances.

E. Motivation Behavior

In this analysis, the motivation of the learners is identified based on intrinsic and extrinsic motivation (Razali, N. et al., 2020). Intrinsic motivation is determined by the participation of the students in all the activities and teaching methodologies without e n t 6 s' i

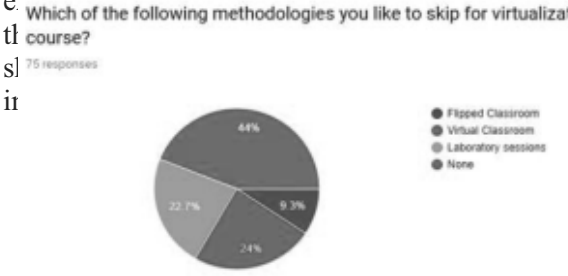

Fig. 16 : Intrinsic Motivation

Extrinsic motivation involves rewards, marks, and internals to be awarded for the student's participation in all the activities. The influence on extrinsic motivation is given in Fig. 17. which reflects 56% are

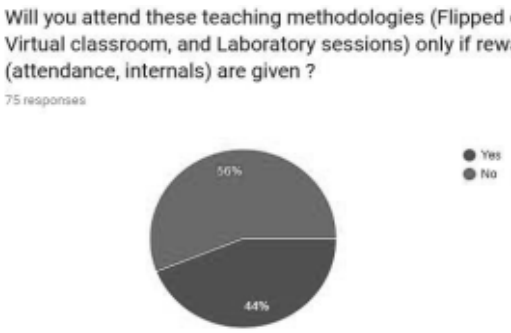

Fig. 17:. Extrinsic Motivation

willing to attend the activities without rewards or attendance. 44% of students are willing to attend all the innovative techniques only based on rewards, attendance, or marks.

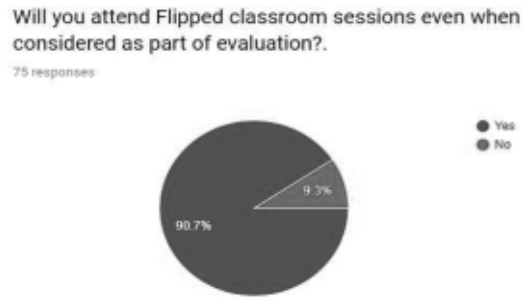

Fig. 18 : Extrinsic Motivations for Flipped Classroom

Fig. 18. shows the extrinsic motivation behaviour for the flipped classroom and it is found that the learners are willing to attend flipped classrooms even without rewards or marks.

Learners Feedback

The sample students' feedback is given in Fig. 19. and

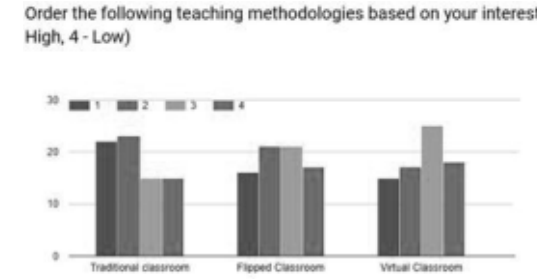

Fig. 19 : Student Feedback

it represents the rating of teaching methodology based on the student's interest. All educational methodologies are preferred by the learners which act as a constructive path to acquire knowledge, competency, and skills.

F. Identify the slow learners

Table 1 : Slow Learners

S. No.	CAT 1 Marks	CAT 2 Marks
1.	14	12
2.	10	15
3.	17	15
4.	17	12
5.	19	19
6.	19	12
7.	17	13
8.	17	14
9.	16	15
10.	18	16

The final component of this research is to find the slow learners and the influence of various models over slow learners. Table 1 shows the number of slow learners who scored fewer marks in CAT 1 and CAT 2 assessment tests.

The number of students who scored less than the passing marks in both of the assessments are considered slow learners and the count seems to be very low. With 142 students participating in this research analysis, 14 students are identified as slow learners for CAT 1 and CAT 2 assessments in the traditional classroom approach. The number of students who consistently scored fewer marks in innovative educational methodologies like the virtual classroom and flipped classroom is zero.

Hence, it is concluded that there are no slow learners who performed low in all these strategies. This also reveals that the students are motivated towards new teaching methodology with the improvement in ICT tools and models (Kanyanina, T. et al., 2020) which increased the performance and the motivation level of the learners.

6. Conclusion

The gaming platforms are always exciting and appreciated by Gen Z learners. This gaming framework gives better results when applied with a properly structured approach and guidelines. Engineering students in the age group between 18 - 21

years are highly influenced by mobile and PC games. The learners consider this as fun, enjoyment, and a hobby. Hence, the advantage of the gaming environment gives a positive approach to teaching the students with the course contents coupled with games. The students find it interesting and involved in the activities with enthusiasm and also learn the given concepts.

In this research work, game-based learning was adopted in the flipped classroom to measure the impact of the gaming platform on engineering courses. The out-class sessions are engaged with course contents in video format and in-class activities involve game-based learning using an online gaming platform called Kahoot. The new model termed CAM-S is proposed and performance measurement is done for the undergraduate students for the virtualization course. The CAM-S has helped in measuring the cognitive, and affective behaviour, motivation, and the number of slow learners in the respective course. Further, this work also measured these behaviours in the flipped classroom by using game-based learning to examine the proposed model's impact on the learners.

Furthermore, the educational technology strategies like virtual classrooms and flipped classrooms were compared with traditional classrooms. Using CAT 2 marks, the students were grouped using the K-Means clustering algorithm to predict the various implications of this research work. The clustering also helped the facilitator to understand the learner's behaviour towards the teaching methodology used. The cognitive behaviour is measured using assessment marks across all the techniques and it is observed that the innovative learning patterns gave enhanced students' performance when compared with the traditional classroom. The affective behaviour is measured using students' feedback and sentiment analysis is used to measure the positive or negative emotions for the courses.

The sentiment analysis for the flipped classroom has higher positive responses or emotions among the other learning techniques. The feedback reveals that the learners are motivated to attend any new pedagogical model with more preferences and interest shown for the flipped classroom. Intrinsic motivation was high among the learners when compared with the external motivational factors.

The final objective of this research work was to identify the slow learners who scored low marks in all the techniques consistently. The inferences showed that there were few slow learners for this course from all three innovative techniques. However, when compared with the other pedagogical methodologies the Flipped Classroom has better learner performance. Even, the number of slow learners using the Flipped classroom approach was also very minimal.

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