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Research article

Learner-generated YouTube presentations for formative assessment

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Abstract: The purpose of the present research was to study the efficacy of learner-generated videos published on YouTube as a formative assessment method. The impact of the assessment method on students' learning and satisfaction, peer learning, group dynamics and skill development was analyzed. An emerging innovation within assessment was done with the students of an undergraduate computer science course during the COVID pandemic. Fifty-four students (teams of three to four) were instructed to create YouTube videos explaining the database design of a case study, peer-reviewed by views and likes. A mixed-method approach with a sequential study design was employed. A questionnaire with 25 questions on learners' and groups' attributes and four open-ended questions was administered. This was followed by a semi-structured interview comprising 19 questions. The quota sampling method was used for selecting a sample of students for interviews. Content analysis of interview transcripts was performed with the NVivo software.

During the experiment, we faced a challenge due to a lack of confidence among some students in public speaking. However, the innovative and engaging assessment resulted in the active participation of learners. Development of new skills like communication, peer bonding, teamwork and resolving conflicts was observed. Additionally, a fair and transparent grading methodology was a satisfying experience. Subject learning and video editing knowledge were enriched by peer learning. The results of the study revealed that publishing learner-generated videos on YouTube had a positive impact on students' learning and satisfaction. We therefore recommend the same as an effective tool for formative assessment.

Keywords: higher education, peer learning, soft skill enhancement, active learning

1. Introduction

Learning through social media became indispensable during the pandemic and facilitated communication between students and faculty, provided access to course materials and fostered student communities. Studies conducted on the impact of social media on learning demonstrate that students' learning accelerates due to the use of electronic communication technology. They can create, modify and share text, video and audio course materials using social media.

Both students and educators acknowledge that online videos are effective for learning. When the entire world was shut down due to the pandemic, the teaching-learning process continued in an online mode, becoming successively important. Initially, conducting and attending classes in a 100% online mode was not a pleasant experience for both learners and teachers. However, it gradually improvised and teachers came up with strategies that engaged and encouraged the students to learn.

YouTube, a free and extensively used platform for publishing and viewing videos, has recently emerged as a popular media for teaching and learning. The present work focuses on the use of learner-generated YouTube videos as an innovative method of assessment. It emphasizes on student feedback toward the use of YouTube in collaborative project work in an undergraduate Computer Science course.

The experiment of having a video presentation as a formative assessment tool was envisioned during the COVID-19 pandemic lockdown. In such a scenario, the purpose of running the experiment was to help the student be better engaged with online classroom learning. At the time of the experiment, the students had already been studying in an online mode for close to two years. The experiment was designed to raise the decreasing motivation of the students by introducing a novelty in the mode of assessment and to make learners actively engaged in the learning process.

The students were asked to produce video content to explain their database (DB) design for a given case study. In the problem-based learning approach, students worked in teams to create the videos and finally published them on YouTube in a channel that was operated by the instructor. Since the experiment was conducted during the COVID-19 pandemic, the students had to collaborate online. Moreover, the views and likes gathered by the videos posted on the YouTube channel were used for grading.

Being a group activity, we hypothesized that it can benefit in developing better group dynamics, interpersonal skills and friendships. It was expected that making the video presentation could help enhance digital technology knowledge while engaging the learners in active learning.

A repository of all the presentations was created via a YouTube channel to help in peer learning where each group could see the working style of the other group. Further, the likes and views for the YouTube videos were embedded in the assessment as a mechanism for feedback, which can further help in improving one's own work.

The study has shown that assessment based on student-generated video creation during the COVID time supported developing skills relevant to today's world. The study also reveals that creating YouTube videos as an assessment tool during COVID-19 transformed them into active learners rather than just passive consumers of knowledge. As the students collaboratively generated and published the videos, the benefits of teamwork and collaboration apart from increased motivation and engagement were also reported. The present work holds significance as it supports the use of student-generated video creation as a method of formative assessment.

The rest of the article is organized as follows: Section 2 reviews the related literature. The research

questions and objectives are clarified in Section 3. Section 4 details the experiment methodology. Results are presented in Section 5. The findings and recommendations are discussed in Section 6. Section 7 concludes the article.

2. Literature review

Digital media has penetrated every sphere of education including the dissemination of information in the form of online classes, video lectures, communication tools between students, teachers and peers, submission of assignments, online examinations etc. [1–8].

Videos have been successfully bridging the gap between theory and practice as a tool for feeling of experience, where real-life experience is difficult to simulate [9]. Recently, YouTube in particular, has been used as a learning platform and its use is increasing exponentially [10–16].

It has been observed that the students are both the consumers and producers of video content, mostly related to entertainment [5]. A segment of students is utilizing this media for cocreating academic content. Various applications of such learner-generated videos (LGVs) [17] for YouTube can be seen, such as presenting guided virtual tours of monuments and institutions [18], exhibiting laboratory experiments [19], sharing medicine, surgery and nursing experiences [20] etc.

The impact of LGVs for YouTube on learning consequences and approval of the students was investigated in a study [21] that demonstrated the use of YouTube as a teaching-learning tool. The authors of [12] conducted a study to research the elements of higher education that would affect the YouTube assignment. Along with that, the self-development of the students was examined. Being an ungraded assignment, the seriousness of the students could not be ensured and, hence, no evident improvement in the English speaking skills was observed. However, six elements of students' self-development were enhanced, which were: Conduct, abilities, convictions, surroundings, identity and mission. Further, it resulted in the improvement of technical skills in developing videos.

Several case studies can be seen in the literature regarding the assessment of YouTube LGVs. The authors of [20] present one such study in the field of nursing where 29 students were given the assignment of making a video presentation about the different techniques of diagnosis in medical imaging. The assignment was self, peer and teacher assessed, wherein the results showed that these assessments help in developing curricular and cross-curricular competencies among students.

Learner-generated digital media (LGDM) was used in learning geological subjects [22]. The findings confirmed the increase in the creativity of the learners. The authors of [23] used five science subjects to design, implement and test the LGDM as an assessment tool. The 33-step questionnaire was used as an instrument for data collection and eight elements were studied: Pedagogy, training of students, video hosting, marking schemes, contribution of group, feedback of learner, reflection and evaluation. The findings identified the support of videos as an important component of the student's learning experience. Students had a positive attitude toward LGDM. They enjoyed the group work and found this tool to be creative [23].

Another study was conducted to study the impact of digital media assignments for undergraduate science education [24]. Four theoretical models were used to identify the need for digital media training and the development of effective marking rubrics. Qualitative surveys, open-ended questions and group contribution were among the tools used for data collection. Students' enjoyment in learning digital media and working in groups was concluded in the study [24].

In the literature, theoretical frameworks have been proposed to identify the digital media training needs and the development of assessment weightings. The study was based on four years of data using the validated questionnaire. Students' attitude toward digital media support and understanding of the assignment was observed. The results suggested a positive inclination of students toward learning through digital media assessment [25].

A study on undergraduate marketing students was conducted, wherein students' perceptions and satisfaction with the YouTube presentation assessment were analyzed [26]. The study's results confirmed this tool's high satisfaction level, perceived usefulness and ease of use.

Another study on engineering students was conducted to improve oral communication [27]. A nongraded assignment of video creation was assigned and an assessment was performed using self-assessment and peer feedback. The traditional method of presentation with the approach of video presentation was compared using a quasi-experimental design. However, the results found no significant improvement in the presentation skills, which was attributed to the nongraded nature of the assignment.

Third-year pharmacology students were assessed based on presentations on the YouTube channel [28]. Mixed-methods approach involving a 35-step questionnaire and five open-ended questions was used to evaluate the intervention. A high response rate was observed.

The above review indicates that despite the increase in the use of video presentations as an assessment tool, there are some gaps related to its design, implementation and evaluation. In the present study, we aim to add to the literature and introduce an innovative formative assessment methodology based on LGVs published on a YouTube channel.

3. Research questions and objectives

This study was conducted for Computer Science students at a central university in India. It was observed that the students were losing interest in the online teaching mode at the end of almost two years of lockdown due to the COVID-19 pandemic. Lack of conceptual clarity due to irregularity in attending online classes was visible at the same time. The experiment was designed to provide a novelty to the online teaching mode, focusing on making learning enjoyable for the students while allowing them to engage in the peer group.

The experiment faced the challenge of teaching mode changing from online to offline mode midway through the semester, even requiring a hybrid format for two weeks. However, the enthusiasm of the students was not dampened. Additionally, decisions like having a common YouTube channel, assessment based on the number of views and likes and omitting classroom presentations were taken through a poll or via a show of hands in the class, boosting morale and confidence.

In the study, answers to the following questions were sought:

1. What is the opinion of the students regarding creating and publishing videos on YouTube as an assessment method?
2. What is the effect of creating and publishing videos on YouTube on the learning of students?
3. What skills did students acquire as a result of creating YouTube videos?

Based on the above research questions, the following research objectives were examined:

- To study the impact of YouTube LGVs as an assessment tool.
- To study the impact of YouTube LGVs on students' learning.
- To study the impact of YouTube LGVs on group dynamics.

4. Experiment methodology

This research used both quantitative (questionnaire) and qualitative (interview schedule) data to gain an understanding of student satisfaction and learning, group contribution and the process of assessment. The study was conducted in Spring semester of 2022 for a Computer Science course in a central university in India. 54 Students worked in groups of three or four students (15 groups). 12 were female students. Each group picked a DB design question in consultation with the faculty. The groups were formed voluntarily by the students. Seven out of 15 groups involved only male students. Interestingly, there were no female-only groups.

4.1. Setup of the task

In the experiment, the students pursued their chosen case study and developed a detailed statement of interest in discussion with the faculty. Each group was allowed to publish a maximum of five videos totaling a maximum of 15 minutes to showcase their work. In the end, 29 videos were recorded in total. The students were encouraged to start the task of creating and publishing the videos as soon as the problem statement was approved. A nodal person selected by the group held the responsibility of publishing the videos on YouTube.

The steps in developing the solution for the case study and the expected submission schedule were shared with the students at the beginning of the experiment. The students developed the solution for each step and submitted it as a separate component through the Google Classroom platform. The solution for each step was then explained in a video that was published on YouTube. The videos also explained the decisions made by the group and their reasons for arriving at the solutions.

The project was a team-based task. The group participants were chosen by the students themselves. Each group designated one student as the nodal point. The videos created by each group were uploaded on the same instructor-owned YouTube channel, created specifically for the project. Groups' nodal students received permission to publish the videos on the channel. However, the channel's existing content could not be edited by the students.

The YouTube channel was made public. However, the students were given the choice to make the videos public or keep them private. Commenting was turned off to protect the students from unnecessary interaction with the public.

The grading was based on multiple components— theoretical understanding of the technical concepts, the content covered in the videos and efficient use of time in the videos. The views and likes garnered by the videos were also a component of the grading. However, each group was given the option of earning the same through a classroom presentation.

Regular check-ins with the instructor were embedded in the experiment. The students could clarify their doubts and were made aware of the requirement for improvements, if any.

Based on the obtained results, the study affirms that the experiment had a positive impact on the learning of participants. The experiment measured the outcomes through a mixed-method approach. While a quantitative measurement was performed through a questionnaire administered to the students,

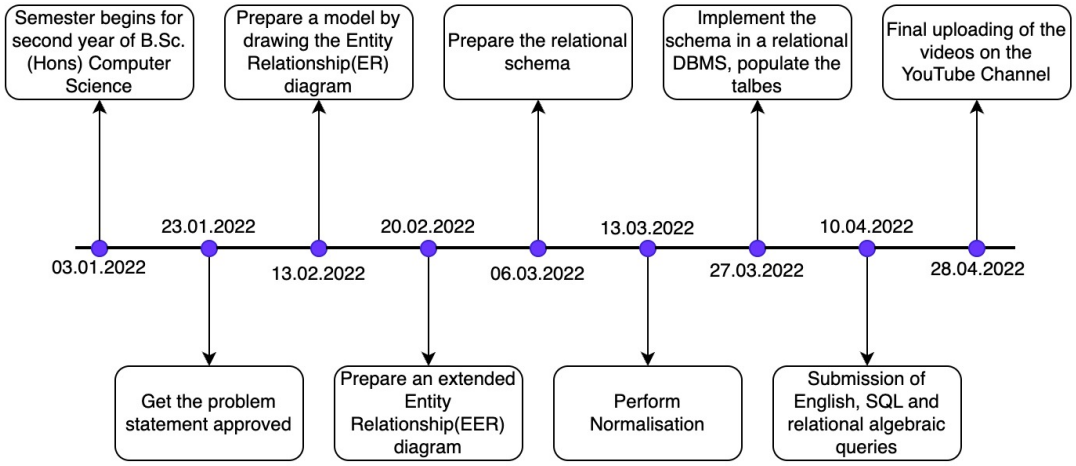

Figure 1. The timeline spread over the semester, provided for each step of the experiment.

interviews were conducted for qualitative feedback. The students appreciated the uniqueness of the formative assessment approach where student-generated videos were published on YouTube. Their active participation in the experiment resulted in improved learning of theoretical concepts as well as their applications. Moreover, working in groups provided an opportunity to develop interpersonal skills such as problem-solving, decision-making and conflict resolution. The experiment started during the last quarter of the two years of COVID-induced lockdown, mostly an unpleasant experience for both learners and teachers. The participants found the experiment to be a satisfactory experience. The students also appreciated the fairness and transparency of grading in the experiment.

4.2. Research context and pedagogy

The study was conducted for second-year (third-semester) students pursuing a three-year undergraduate degree. In the third semester, students are required to pursue the following courses: 1) Three core courses of six credits each, 2) one skill enhancement course of four credits and 3) one general elective course (from a different discipline) of six credits. Each of the courses is accompanied by project/lab work. As a result, student workload is high. However, a clear timeline (Figure 1) spread over the semester was provided for each project step. Students were encouraged to discuss their progress after each step. It was mandatory for each group to submit their progress through the Google Classroom platform upon completion of each step.

This research examines the impact of integrating YouTube videos as one of the modes of assessment in a university course (Database Management Systems). The students were pursuing an undergraduate degree in Computer Science at a major central university in India. The course is compulsory for students in the second year. The course is appropriate for this project as the evaluation for the course involves multiple activities carried out during the semester along with an end-of-semester exam. Also, the expected outcomes of the course could be easily mapped to the objectives of the project. The student's learning of the course has a 25% component of continuous assessment and a 75% component of an end-semester examination. Due to the lockdown of COVID-19 time, the students were more comfortable with the new-age technologies for their presentations. Students found the chance to make

a video for YouTube more attractive than just making a video. As a result of producing and viewing audio-visual material, students not only gained knowledge of the course material but also developed new skills.

The Database Management Systems (DBMS) course is technical in nature and is at the beginning of the second year. The students were not yet exposed to many live oral presentations or group-based projects. However, the students had an experience of working in an online group setup. Additionally, considering the technical nature of the subject matter, the presentation of technical content plays a crucial role in oral presentations.

The experiment was devised in January 2022 while the teaching was completely online (since March 2020) due to the COVID-19 pandemic. The teaching mode became offline mid-semester during the project, around the time when the students were preparing to start the video recordings. It turned out to be beneficial as it gave the students an opportunity to have greater peer interaction and the chance to learn within and between the groups.

Students worked in small groups and were assigned a well-defined problem statement with clear objectives. A previously decided time window was provided for publishing the videos on YouTube. The groups were allowed to be inspired by the videos published by other groups. There were regular check-ins where each project involved a discussion with the instructor. The students were encouraged also to discuss any issues related to group dynamics. Pedagogy suitable to the project was found to be experiential learning, problem-based learning and collaborative learning.

4.3. Development of the project

In the project, a YouTube channel was created by the instructor. The videos published on the channel were vetted for quality and moral requirements to ensure that the content was appropriate to the standards of a university. The students were permitted to publish the videos on the channel. However, the students did not have the permission to delete or edit existing content.

The students voluntarily participated in the project and started by creating self-decided groups of two to four members. Each group deliberated on picking a topic for the design and implementation of the database and discussed the same with the instructor. Once the topic was approved, a detailed specification sheet was developed by each group. Each group was allowed to publish from one to five videos to explain the concepts related to the database design for their case study. The maximum time limit is 15 minutes for all videos combined. It was mandatory for each student to be visible at some point during the videos. In each group, a member was picked by the group to act as the nodal person with the responsibility to get the videos approved by the instructor and to publish the videos on the instructor's YouTube channel. Depending on the time of posting, the students were given approximately three weeks to one and a half months to view, share with others and like the videos before the end of the semester.

To motivate student engagement, they were informed that the project would contribute to 20% of the continuous evaluation component. The continuous evaluation accounts for 25% of the total assessment of the course. The rest of the 75% is assessed via a written university examination. In the course on DBMS, 20% of the continuous evaluation is based on attendance, 40% is based on a class test and the remaining 40% is to be decided by the instructor.

At the beginning of the course (DBMS), an introductory session took place to explain the activity. The objectives of the project were presented. The procedure, requirements and guidelines for executing

the project were explained. Since technical students in their second year were participating in the project, it was expected that they would be able to acquire the requisite competencies for working with digital media. The instructor was equipped with about five years of software development experience apart from more than 20 years of research and teaching experience. The instructor took care to discuss the issues of software and hardware requirements for creating videos, video quality, effective presentation of content using digital media and copyright issues.

4.4. Marking scheme and feedback

The project accounted for 10% of the final subject mark. A marking rubric was designed and shared at the start of the project. The grading components included the completeness of the tasks and the correctness of the presented concepts. In addition, the creative use of videos to make the topic more interesting for a wider audience and efficient use of time in the videos was also included as a grading component. Theoretical understanding of the technical principles and the views and likes earned by the videos also contributed to the grading. It was required that each student be visible at least one point during the videos. Marking rubrics included the proportion of visibility during the videos of each group member and the best use of the allotted time in proportion to the importance of the concept being discussed.

We recognized that some students are hesitant in public speaking. Additionally, some students might come from very traditional backgrounds. The groups were given the option to make the videos private (viewable only to their classmates) or public (viewable to any YouTuber). Furthermore, the students were given the option of replacing the grading component based on views and likes with a classroom presentation. In addition, commenting on the videos was turned off to protect the students. In the experiment, the students did not experience any cyberbullying or cyber-mobbing.

The project was the first such activity where the students engaged in face-to-face peer group interaction and learning after the pandemic lockdown. Students were motivated to assess individual contributions to their groups and verbally share their feedback with their peers. However, marks were not assigned to the variations observed due to the group dynamics.

Regular check-ins were embedded during the course of the project. Students were encouraged to schedule time with the instructors, either individually or as a group, to discuss any issues whether technical or otherwise. This helped the instructors provide regular and constructive feedback to the students. The check-ins started with a student-led discussion. After that, the instructor gave feedback woven around the goals, current progress and future direction. This helped the students to modify and improve their work.

4.5. Expected outcome

The study examines teaching practices that facilitate students' learning using learner-generated content. The approach involved group work. Students collaborated to produce videos that were shared on a dedicated YouTube channel. An instructor-owned YouTube channel was created for the course. Each group picked a case study approved by the course instructor. In the videos, the students explained the concepts related to database design with the help of the picked case study.

The study investigated the students' perspectives on the usefulness of YouTube as an assessment tool in a science course. The present work aims to propose an innovative assessment mechanism

for future curriculum changes. The current work examines how students' perceptions of learning are impacted by their involvement as creators of content. The students exhibited satisfaction with the assessment and the course, grading methodology and their academic performance. The experience of video creation could entail instruction on the utilization of software programs for video editing. Using YouTube for its dissemination may allow for developing capabilities such as technological competence or social skills required to successfully work in groups. The developed competencies can be applied in any field [29]. In addition, a component of the assessment was based on likes and views generated by the video. Creating videos that presented information in a way that captured the viewers' attention may also promote the creativity and cognitive abilities of students [30].

4.6. Evaluation

The class comprised 57 students at the beginning of the semester. Three students left the program mid-semester to pursue other opportunities. The highest grade attainable by students for the project was set at 10% for the DBMS subject. At the end of the semester, the grades were assimilated and shared with the students. After the semester ended, formal feedback taken via a questionnaire was administered with 15 questions on Learners' attributes, 10 questions on groups' attributes, and four open questions. The questionnaire involved the entire class since all the students had participated in the project. However, the students were given a choice to participate on a voluntary basis and formal consent was taken from them. 53 students participated out of the 54 students who had completed the project. Thereafter, using the quota Sampling method, a student was picked from each group and was given a choice to participate in the further feedback process. An R language script was written to implement the non-probabilistic Quota sampling method. There were 15 students, one from each of the groups, who participated in the interview process. 19 questions were asked in the semi-structured interview format. The interviews were recorded and transcribed. Figure 2 shows the steps taken to conduct the study. The questionnaire and the interview questions were in alignment with the goals of the study, namely, satisfaction with the assessment, students' learning, peer learning, development of skills and group dynamics.

In the first phase of data collection, a questionnaire with a five-point Likert scale was constructed and the students indicated their level of agreement with the statements ranging from one "strongly disagree" to five "strongly agree." Information about the student's age, gender, the type of computer used to access online content and the type of internet connection was also collected. It is worth mentioning that the feedback survey was conducted after the final grades had been released. This was done to prevent any bias in respondents' answers resulting from concerns about the impact on their grades. The study, therefore, is a combination of objective (via questionnaire) and subjective (via interviews) measures to avoid bias due to measurement method, a common source of measurement error [31]. The next step after data collection was to do frequency analysis to organize the data meaningfully.

5. Results

Figure 3 shows the frequency analysis for the following themes of interest:

Satisfying Experience: 49% of participants believed that the experiment's educational outcomes were

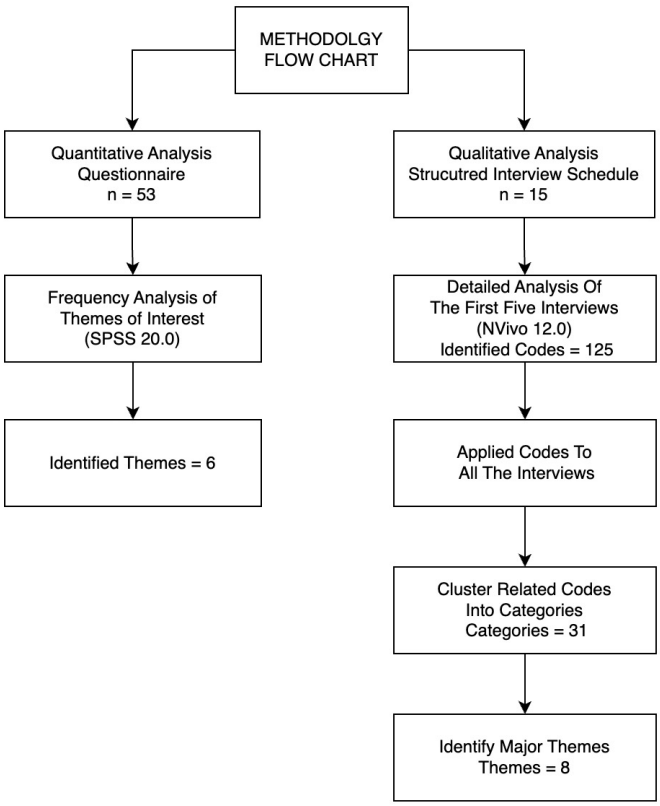

Figure 2. Flowchart for the methodology used in the YouTube experiment.

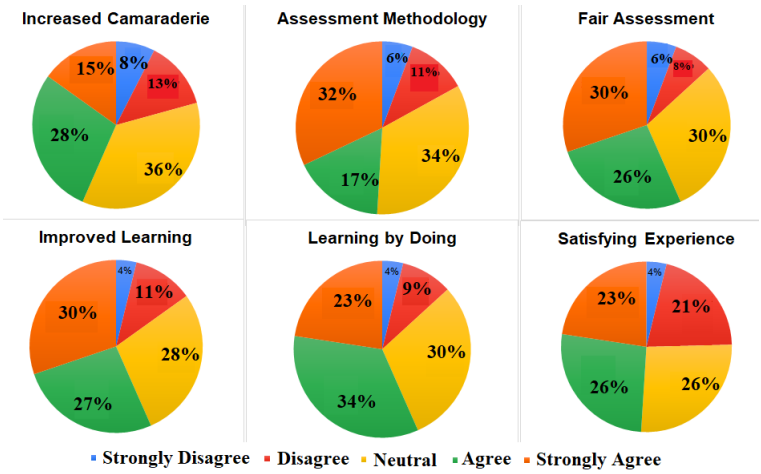

Figure 3. Frequency analysis for the themes of interest in the YouTube experiment.

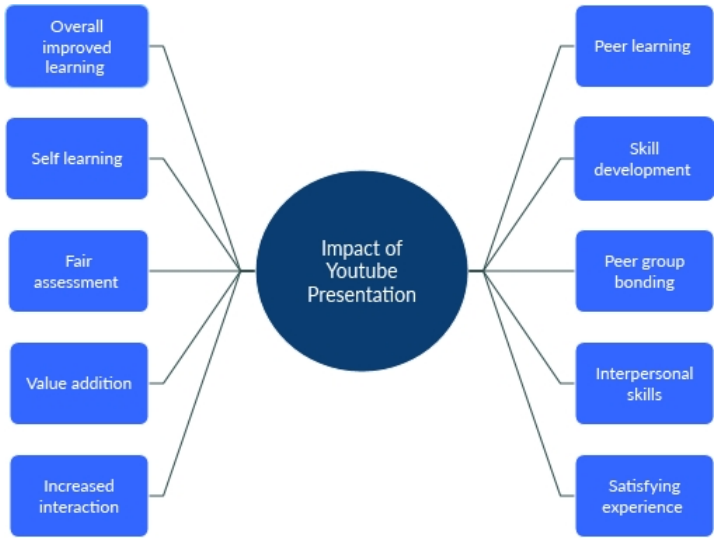

Figure 4. Conceptual mind map of YouTube experiment.

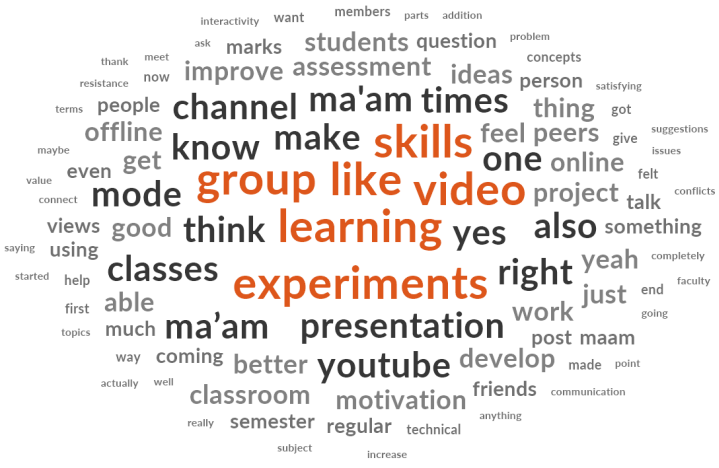

Figure 5. Content analysis by NVivo software to obtain word cloud for the YouTube experiment.

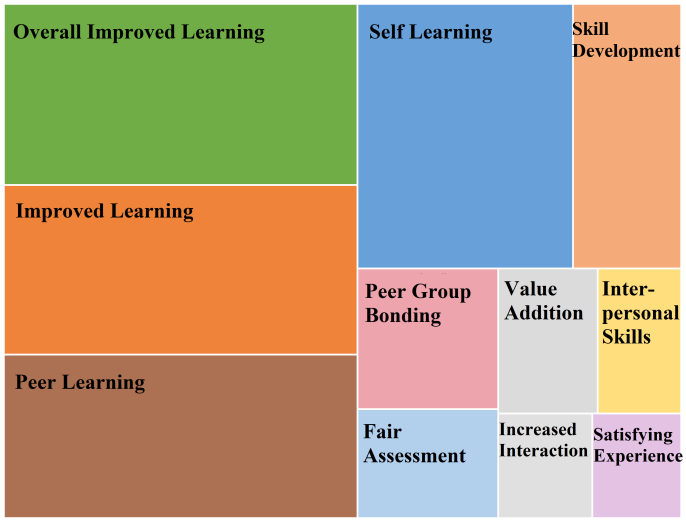

Figure 6. A tree map prepared by NVivo software for the YouTube experiment.

satisfactory. Regarding the learning outcomes, 26.4% of the participants were neutral. 24.6% of the participants did not feel that the experiment added any value to their learning.

Learning By Doing: Only 13.2% of the participants felt that the experiment did not contribute to the learning of the concept. However, 56.6% of participants agreed that the experiment was innovative and helped them in the learning of the concept. The remaining 30.2% of the participants were neutral about the learning outcomes.

Assessment Methodology: 49.1% of participants wanted the assessment methodology to continue in the future. 34% of the participants were neutral. 17% of the participants did not agree.

Fair Assessment: 56.6% of participants agreed that the assessment was fair for the group. 30.2% of the participants were neutral. 13.2% of the participants had a disagreement about fairness in the assessment process.

Improved Learning: Participants who felt that their active involvement in the experiment led to better learning outcomes amounted to 56.6%, whereas 28.3% of the participants were neutral. 15.1% of the participants did not agree with this finding.

Increased Camaraderie: Although around 43.4% of participants felt an increased camaraderie in the group due to working together in the experiment, 35.8% of the participants were neutral. 20.7% of the participants did not find any change in camaraderie.

The second data collection phase used a structured interview schedule comprising 19 open-ended questions. The interviews of 15 randomly chosen participants were conducted virtually. 11 participants were male and four were female participants. The interviews that were recorded were transcribed by the researchers. The length of the interview was half an hour, on average. This was followed by the coding of the interviews, which was divided into two stages. The first step of the analysis involved initial coding through NVivo software. NVivo is a computer software designed for qualitative data analysis (QDA), which has been used to analyze the qualitative data collected from the students. The software helps in organizing, analyzing and uncovering insights into data such as interviews, open-ended survey responses and web content. The version that has been used in this study is NVivo 12.0. After coding was done, the researcher was able to get many similar codes, which were aggregated under broad categories. The codes and categories identified by the researcher were cross-examined by

the other two researchers to validate the data further.

Figures 4 and 5 show the conceptual mind map and the word cloud for the experiment generated via the process of content analysis by the NVivo software. Concept maps, also known as mind maps, are graphical representations that illustrate the associations between various concepts.

Figure 6 depicts a tree map prepared by the NVivo software. A treemap is a visualization technique that enables the representation of both the size of the main categories and the size of their larger subcategories in a single display. To compare the frequency of coding references, a treemap of nodes is generated, where a node with a greater number of coding references would appear as a larger rectangle.

Table 1, presented in the appendix of the present work, represents the codebook for the YouTube experiment. The codebook shows the themes and the associated codes. NVivo's qualitative analysis produced 31 categories, which were put in eight themes for discussion. These themes are discussed below.

- Theme 1: Motivation for choosing YouTube
- Theme 2: Improved Learning
- Theme 3: Peer Learning
- Theme 4: Self Learning
- Theme 5: Development of Skills
- Theme 6: Interpersonal Skills
- Theme 7: Fair Assessment
- Theme 8: Challenges

5.1. Theme 1: Motivation for choosing YouTube

When participants were asked about the motivation behind choosing YouTube Videos over class presentations, varied responses came from their side. The most obvious reason was that they were all excited to publish their video on YouTube. For most of them, it was a 'novel' and 'unique' idea and altogether a new experience. Most of the participants readily accepted the idea as they wanted to see themselves on YouTube.

"On YouTube, we can present in front of many people and in-class only we can present in front of fellow mates."

They also liked the idea of 'likes' and 'views' as it reached a wider audience. Working in teams during COVID-19 in online mode was also a reason for them to accept this evaluation method. Participants also felt that it was convenient to shoot a video and mistakes in a video can be easily corrected, which is not possible in classroom presentation. They also reported that publishing of videos ensured marks to them, which helped them to decide in favor of this assessment. Getting likes and videos was easier for them compared to marks in classroom presentations.

In class presentations, participants were also afraid of faculty cross-examination, which made them dread losing marks. However, if they were able to get the desired number of likes and views for their video, they knew they would get good marks, so YouTube videos were favored more. After being quarantined at home due to an epidemic, it was difficult for students to leave their comfort zone and speak in front of the camera.

An insignificant percentage of participating students showed resistance to the experiment. The resistance was mainly due to the quantum of work involved in making videos. They also felt that a lot

of coordination would be required in completing the experiment, which may not be possible in online mode. Some of them perceived that getting likes and views would not be easy and that securing marks in class presentations was easier.

The participants were already equipped with the technical skills to perform the experiment, hence, there was no resistance on that account. The fact that all of the groups' videos are published to a single YouTube channel so that users can view the videos of other groups was also enjoyed by the participants. A shared channel for all the videos would make it easier for future batches of students entering the course to comprehend both the idea and its implementation.

"I think your channel would be better because if every student starts creating their channels, there will be a lot of channels". "Your channel was a centralized way to post our videos and we could also easily watch our other group mates' videos."

5.2. Theme 2: Improved learning

One of the most significant themes of the experiment has been overall improved learning, which has been recognized by the participants. The result of the qualitative analysis shows that the teaching and the assessment designed in the experiment encouraged the students to actively learn the concept as well as the skills involved in applying it. The experiment required continuous and active involvement of students, which improved their overall learning. The result implies that learner-generated content can be used to make the learning of the concept and its application effective in the classroom.

The result also supports the fact that students benefit from group work strategy and it affects their performance, skills and behavior. When they work in a group to solve any academic problem, they become active learners and become the center of the learning process. Students who participated in the experiment took individual responsibility for developing the content and group responsibility for making the videos. As a group, they also took collective responsibility to ensure that their group got enough likes for their video. To successfully complete the experiment they divided the work amongst themselves, which helped them meet the deadlines. Although they were facing the challenge of shifting from online to offline mode, the spirit of cooperation developed during various stages of the experiment and helped them to complete the experiment.

The regular check-ins incorporated in the experiment helped the faculty to provide support wherever required. Working in groups also made them learn to respect the views of others and accept them. The experiment also helped the students develop an ability to solve problems, participate in problem-solving and make decisions. It also increased their confidence. The experiment necessitated active participation from the students and implemented transparent evaluation criteria, which served as a clear incentive for student learning and improved performance.

5.3. Theme 3: Peer learning

Peer learning is inherently involved in a group project. It improves the level of learning because one ends up asking each other and talking about it, then turning it in.

Much learning happened mutually from each other as the group members had divided the topics amongst themselves. The participants also observed that as some of them were making videos for the first time, they had to take help from the students who were adept with the skills required to make videos.

5.4. Theme 4: Self-Learning

The study also found that the second important theme is self-learning. Many participants reported that the experiment led to self-learning as they gathered, processed and retained the knowledge required to execute it. To work on the project, the participants had to explore alternative approaches, which supported self-learning.

The participants learnt skills required to edit the videos on their own, which was not provided in the class. The participants also reported that the experiment helped in getting better knowledge of the subject. Although the faculty provided the theoretical foundation of the course, the experiment helped students in gathering and processing information that was required to solve the case as a part of the experiment. As the experiment involved a component of learning by doing, it turned out to be a very satisfying experience for them. Participants were engaged both in "doing" and "reflecting", which added to meaningful learning. The learning of participants was enriched by understanding the concept and its application in solving a real-time problem.

"It was not only about learning the subject, but it was also the application of the subject which connected the dots for us."

"I stayed motivated due to constant encouragement from my teammates."

5.5. Theme 5: Development of skills

The experiment also helped the participants to acquire technical skills such as video editing, Canva, etc. Even though there was no direct contact between the participants during the first half of the experiment, they were still able to handle the technical problems related to the project.

As the groups were expected to make a video based on the picked case study, many participants admitted that it helped them polish their communication skills. The participants also acquired teaching skills as they knew they would be teaching a wider audience through their videos published on YouTube.

5.6. Theme 6: Interpersonal skills

One significant finding of the experiment is that each group was capable of creating a problem-solving strategy and resolving issues that arose throughout the experiment.

The groups eventually evolved into teams that could overcome their obstacles on their own. The majority of the problems were settled through communication with one another. Additionally, they discovered how to work together and resolve disagreements by communicating.

"I learned that we need to cooperate with each other and we need to see what it is that our group member needs and how we can help him or her."

Participants also emphasized how they were able to enhance their speaking abilities and get over stage fright, which many of them had as a result of having missed out on the chance due to the pandemic.

"We used to talk with each other and then come up with a solution that was best for the experiment."

"Initially there was some resistance because it was a daunting task for people to record themselves at first but when they started doing the work for the project, it only made sense that after the hard work for such a project, you got to show it off to people. So, yes, there was some resistance from my teammates, but it eventually went away."

Participants also mentioned that viewing other people's films motivated them to communicate more effectively in their videos. Group projects typically encourage social contact, which was true in this experiment. The participants formed close ties with one another while carrying out this experiment and they were able to forge social links outside of their course through their videos. The experiment's regular check-ins and deadlines helped the participants manage their time.

Another significant result shows that, despite the participants' lack of prior acquaintance at the start of the experiment, they were able to forge strong friendships by its completion. Because of the pandemic, this group had not personally met or engaged with one another. The experiment provided them with an opportunity to do so frequently. It encouraged the participants to communicate more because of the goal of completing the experiment. They were able to complete the exercise because of the purposeful and goal-oriented contact they had while conducting it. A representative example of these comments is:

"Now we all are very good friends and mainly because of the project."

However, participants of some groups initially resisted the idea of making YouTube videos as they were not comfortable teaching or presenting a concept to others. Some students had not done this earlier due to lack of any such opportunity. Their lack of confidence came from the fact that this batch did not have the opportunity to grow from the first semester to the fourth semester in a physical mode.

5.7. Theme 7: Fair assessment process

Regular check-in was a feature of the experiment that received favorable comments from the participants. They had the chance to ask questions, get answers and get the teacher's input on their progress through frequent check-ins.

"Regular check-ins was better because that gets people motivated to commit to the deadlines and complete the project."

5.8. Theme 8: Challenges

The participants found the experiment of creating content and publishing their videos on YouTube a satisfying experience. However, they also faced challenges, which are usually experienced in any new endeavor. Initially, some participants found the idea of recording videos a daunting task and more time-consuming than classroom presentations. They did not find the experiment to be easier than classroom presentations. They also thought that they would face difficulty in getting likes and views. As classes were happening in an online mode when the experiment started, many of them who were irregular in attending classes faced the challenge of understanding the concept.

As soon as college reopened and the transition from online to offline mode happened, participants started feeling demotivated as their schedules became more hectic than earlier. This was due to adjustments required in commuting to the campus as well as the deadlines of other parallel assignments. When participants were studying in online mode, they had more time on hand to complete the assignments and meet deadlines. Some of them also faced challenges due to the conditions of the experiment and the deadlines they were expected to meet. The issue of coordination was also faced amongst the group members, especially when they started coming to the campus to attend classes. The experiment was not devoid of challenges, but participants through collective efforts were able to overcome the hardships.

6. Discussion and suggestions

The innovative experiment conducted to assess the performance of Computer Science students on Database Management Systems through the creation and publishing of videos on YouTube resulted in a very satisfying learning experience. Most of the students stated that the assessment method should continue in the future. Although the students were attending classes in online mode the experiment led to an increased interaction among themselves. The assessment methodology used was divided into phases and expected students to apply theoretical concepts to solve the case picked by them. This improved the learning of the concepts and their application. A significant finding of this assessment methodology was that the students were able to learn from each other and also develop several interpersonal skills such as problem-solving, decision-making and conflict resolution. Due to the pandemic, the participants were not meeting each other, but they were still able to collaborate and work together. They were able to forge strong friendships as they were regularly communicating with each other. The students also found the method of assessment fair and meaningful.

6.1. Suggestions

The following suggestions were provided by the participants as a feedback to the YouTube experiment:

"There could have been follow-up questions in class presentation from the faculty as well as fellow students, which was completely missing in YouTube videos. Cross-questioning from the faculty would have also ensured whether the student has conceptual clarity or is simply reading from the script."

"Students after publishing the videos on YouTube could have been evaluated also on the basis of Viva-voce, conducted by the faculty."

"A lot of these projects are accepted by a lot of firms, so if these projects are conducted in association with some alumni who are working at good firms, that would be really great."

Most of the participants found the experiment a satisfying experience. Following are some examples:

"I would definitely say that it was quite satisfying because we had to do everything from scratch."

"We were naive at the beginning of the experiment and had to learn a lot in order to complete the experiment. Apart from DBMS, we also learned a lot of soft skills, which has further helped us in building our confidence."

"As I was presenting it in front of the camera, I not only put more effort in understanding the concept but I also worked on my presentation skills so that I am able to explain it well."

The participants also found the process of assessment fair and were satisfied with the marks allocated to them for their performance.

7. Conclusions

Based on the obtained results, the study affirmed that the experiment had a positive impact on the learning of participants. A similar study revealed that utilizing YouTube to integrate information technology boosted students' learning in performing arts education [11].

The experiment was conducted for a batch of 54 technology students studying in an undergraduate course at a central university in India. This batch of students was in their first year of undergraduate

education when the COVID-19 pandemic resulted in a worldwide lockdown. The students had been studying in an online mode for close to two years.

The study aimed to develop a novel formative assessment methodology for undergraduate students of the Computer Science discipline. The experiment required the learners to create video presentations and publish them to the YouTube channel of the faculty. Apart from the technical learning, the experiment aimed to make the assessment more engaging and enriching for the participants during the lockdown scenario.

A mixed method approach was used to collect the feedback from the students in which an interview schedule as well as a questionnaire, was prepared and data was collected. A quota sampling method was used for sample extraction, which was followed by analysis of data a. Content analysis of the interviews was done by NVivo software and qualitative data was analyzed.

A similar result was also reached where YouTube was found to be an effective tool that can enhance the learning experience of students [13]. The feedback given by participants revealed that they found the experiment to be a motivating, exciting and engaging method of assessment, which led to improved learning and better bonding with group members. This finding was corroborated by another study, in which pharmacy students considered a YouTube exam to be interesting and learned new abilities that will be useful in their future employment [22]. Following are some examples of positive feedback received from the students:

"Peer learning in the experiment allowed a better learning experience."
"Marks were easier to obtain in this setup."

Improved learning has been one of the most significant themes that came out as a result of qualitative analysis of data. This was complemented by peer learning. The participants who did not know each other at the beginning of the experiment developed strong bonds of friendship by the end of it. Results revealed that the participants found the experiment to be a unique method of formative assessment. Hence, they actively participated, resulting in improved learning. The experiment helped the participants in understanding the theory and the application of it. Participants had positive feedback about regular check-ins incorporated into the experiment, which gave them an opportunity to clarify their doubts and take feedback from the faculty about their progress. Another major outcome of the study was that the groups could develop interpersonal skills such as problem-solving, decision-making and the ability to resolve conflicts within themselves. Overall, the experiment was found to be a satisfactory experience, especially given the COVID-19 time when the students were generally not happy with the online teaching-learning process. The participants also found the experiment to be fair and transparent.

Based on the positive feedback provided by the students, it can be concluded that YouTube LGVs can be used for formative assessment for students pursuing higher education. The results revealed that this mode of assessment has been effective in enhancing students' learning and satisfaction.

Publishing a video on YouTube has pros and cons. Students may not be perfect presenters and may feel shy and embarrassed when their peers tease them about their competencies. Further, students may be recognized on the internet and can be victims of cyberbullying. Any future work in this direction must focus on these aspects also.

In the future, the experiment can be extended to courses in other disciplines such as social sciences

and natural sciences. The experiment can include peer assessment in an offline classroom presentation where a group presents via the generated YouTube videos and their peers quiz them. The alumni of the institution can be involved as group mentors and for feedback and evaluation. Various video creation tools like Vimeo can be explored. Further, future work in this direction will study the implications of using YouTube comments in assessment.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

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Conflict of interest

All authors declare no conflicts of interest in this paper.

Ethics declaration

The authors have obtained informed consent from all participants. The research work has fulfilled all relevant ethical guidelines.

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Appendix

The following table shows the codebook, that is, the themes and the associated codes for the YouTube experiment.

Table 1. Codebook for the YouTube experiment.

S. No.	Themes	Codes
1	Motivation	Convenient to shoot a video
		Excited to publish one's video on YouTube
		Getting likes and views were easier
		Good idea to conduct the experiment during COVID-19
		Mistakes can be corrected in YouTube videos
		Most liked part of the experiment was making YouTube videos
		Motivation stayed throughout the experiment
		New experience
		Preference of YouTube as a medium of presentation
		Readily accepted the idea
		Support of each other throughout the experiment
		publishing of video ensured marks
		Working in team was a motivation
		YouTube videos assured marks easily
		Good to see oneself on YouTube
		Idea of likes & views was good as it reached a wider audience
2	Improved learning	Acquired advanced technical skills
		Improved outcome in Classroom if repeated
		Working in a group was easy
		Learnt editing skills
3	Alternative method	Alternative option of classroom presentation
4	Conceptual understanding	Conceptual understanding by the Faculty
5	Conflict resolution	Conflict resolution was done through dialogue
		Minor conflicts were resolved by voting
6	Conflicts	Conflicts about publishing on personal channel
		Conflicts in initial phases
		No conflicts
7	Division of work	Could overcome initial resistance due to the breakdown of the work
8	Domain knowledge	Experiment helped in getting better knowledge of the subject
		Theoretical understanding provided by the faculty
9	YouTube channel of faculty	Faculty channel is more organized
		publishing videos on common

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S. No.	Themes	Codes
		channel was a good idea
10	Fair assessment	Assessment was fair
		Fair assessment among groups
11	Fear	Fear of classroom presentation
		Fear of cross-questioning in-class presentation
		Loss of marks in classroom presentation
		Nervous in presenting in front of the class
12	First time experience	Attended offline classes for the first time in two years
13	Future possibilities	Element of classroom presentation can be added by recording the video
14	Interaction	Experiment encouraged regular interaction
		Interaction amongst group members was over the phone
		Resulted in more interaction amongst peers during COVID-19
15	Interpersonal skills	collaboration & Teamwork
		Improved communication skills by watching the videos of others
		Increase in confidence
		Learnt team coordination
		Overcame stage fright
		Presentation improves the clarity of concept
		Social connections
		Time management
		Improve public speaking abilities
		Collective problem solving
		Better Communication Skills
16	Learning by doing	Learning by doing
		Learning by exploring
17	Learning from peers	Learning from peers
18	Less workload	Common YouTube channel reduced the workload of students
19	Technical skills	Already equipped with technical skills
20	Novel idea	Making YouTube videos was the first time
21	Outcomes	YouTube videos would help the next batch
22	Peer group bonding	Better Group Dynamics
		Developed bonds of friendship with group members
		Developed strong bonds with each other
		Became more friendly

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S. No.	Themes	Codes
23	Peer learning	Peer learning
		Peer support for conceptual clarity
24	Resistance	Initial resistance
		Lack of coordination in Initial Stage
		Resistance due to too much work involved in making videos
		Resistance for likes and views
25	Satisfying experience	Experience was satisfactory
		Learning experience
26	Scoring	Easier to get likes & views
		Easy to get marks in YouTube videos
		Ensured some marks
27	Skill development	Developed new skills- video editing
		Video making required polishing communication skills
		Acquired teaching skills
28	Suggestions	Better learning in offline mode
		Both the options should have been provided
		Marks distribution could have made the experiment more attractive
		Offline mode would have provided more opportunities for discussion
		Online mode was not a disadvantage in the experiment
		Skill of handling questions was missing
		Softer deadlines would have been better
29	Value addition	Involvement of alumni would add value to the experiment
		Transition from online to offline added value to the experiment
		Value addition to the resume
30	Faculty Interaction	Regular faculty interaction was good
31	Challenges	Daunting task to record a video
		Deadlines
		Demotivated due to other engagements
		Demotivation set in when college reopened
		Difficulty in getting likes and views
		Experiment brought some hardships
		Hectic due to other parallel assignments
		Innovative techniques were used to overcome hardships

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S. No.	Themes	Codes
		Issue of coordination amongst group members
		Lack of conceptual clarity due to irregularity in attending online classes
		More effort required in classroom presentation
		Transition from online to offline mode
		Uncertainty of marks in classroom presentation
		Videos to be posted on students channel
		Wasn't easier than classroom presentation
		Wasn't easy to get views and likes
		YouTube videos are time consuming
		Demotivated due to the conditions of the experiment

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