Exploring Integrated Online Instructional Approaches for Foundation Chemistry I in Malaysia by Utilizing Youtube and Google Classroom

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ABSTRACT

In response to the COVID-19 pandemic, the Centre of Foundation Studies at Universiti Teknologi MARA, Cawangan Selangor, Kampus Dengkil, launched an online Foundation Chemistry I course from August to December 2021, catering to science and engineering students. This course is a notable example of efficient online teaching methods for chemistry. We utilized various applications such as YouTube and Google Classroom to create a network platform. Moreover, we provided personal insights on high-quality online teaching for foundation chemistry. We incorporated various resources shared through Google Classroom to engage students during class, including online notes, prerecorded lectures (also shared on YouTube), and tutorials. Google Classroom provides a platform for distributing quizzes, assignments, and assessments to students, which enables teachers to keep track of their progress and provide them with feedback on their performance. The study revealed that the students performed exceptionally well in their final assessment, validating that our online platform and strategies are highly effective for teaching and learning.

Keywords: Foundation Chemistry I; Google Classroom; YouTube; Online Teaching; Performance

INTRODUCTION

Foundation Chemistry I is a crucial course in the field of chemistry that lays the foundation for advanced learning. The course delves into the principles of mass conservation, atomic interaction, and molecular structure, which are the building blocks of inorganic and physical chemistry. By mastering these fundamental concepts, students can gain profound scientific abilities and practical skills to help them excel in their future endeavours (Friend, 2023; Holme, 2022). The course aims to equip students with a comprehensive understanding of the core principles and their real-world applications, essential for success in the scientific community. Despite the vast amount of information covered, this course is designed to be concise yet informative, allowing students to grasp complex concepts in a relatively short amount of time.

In the Foundation Chemistry I course, students are expected to utilize their knowledge of the conservation of mass, atomic interaction, and molecular structure to address the principles of physical chemistry. Additionally, students must demonstrate proficiency in basic scientific skills related to physical chemistry while also upholding the values, attitudes, and professionalism expected in the field.

In this study, we carried out teaching methods utilizing online classroom platforms and provided a more immersive classroom atmosphere by combining a variety of Foundation Chemistry I-themed scenarios. We went the extra mile to keep students engaged and motivated by incorporating

interactive online quizzes that tested their knowledge level. This made learning more fun and helped us enrich our curriculum and instructional strategies.

PROBLEM STATEMENTS

Many undergraduate science and engineering students struggle with chemistry due to inadequate foundational knowledge of fundamental theories (Cooper & Stowe, 2018; Gupta & Hartwell, 2019). The COVID-19 outbreak in Malaysia in 2021 has made in-person teaching a health risk for students and lecturers, leading to the introduction of the Foundation Chemistry I online course. This course is limited to a student capacity of 30 per class and aims to provide a comprehensive understanding of chemistry fundamentals to help students overcome these challenges. Different network and hardware conditions for students and the indirect communication between lecturers and students completely change the environment and atmosphere of teaching and learning (Barrot et al., 2021; Ngah et al., 2022). Under these circumstances, appropriate platforms and methods should be adapted to improve the quality of teaching and learning. An online Foundation Chemistry I course requires students to be well-concentrated and attentive. Providing various materials to facilitate extra-curricular learning is vital to improve students' attention and participation in the course; thus, many media and technologies have been used (Abdulrahaman et al., 2020a; Mhlongo et al., 2023). For example, lecturers uploaded chemistry-related content videos onto YouTube sites to provide exciting teaching methods for students who could also use these videos as references to complete their assignments and revise what they have learned. Other means, such as chemistry lab experiments, were prerecorded by most of the chemistry lecturers used to help demonstrate actual chemical experiments. The experimental output (EO) for each experiment was also given to the students to test specific scientific skills. In addition, an online classroom via Google Classroom was used as an official site established for better communication and learning between students and lecturers within the online Foundation Chemistry I course. Some teaching theories, such as helping students eliminate inert ideas by creating rich context, could help students engage more in the course.

OBJECTIVE

The purpose of this study has been following specific research objectives, which are:

1. To utilize online classroom platforms specifically "Google Classroom Foundation Chemistry I" and "YouTube".
2. To investigate the knowledge level of students by incorporating interactive online quizzes and online final assessments.
3. To identify the quality of the educational experience by gathering and analyzing feedback from students.

METHODOLOGY

The online teaching platform for Foundation Chemistry I involves two applications, specifically "Google Classroom Foundation Chemistry I" and "YouTube." Google Classroom is a free blended learning platform created by Google for educational institutions that aim to simplify the process of creating, distributing, and grading assignments. Its primary objective is to streamline the sharing of files between teachers and students. In contrast, YouTube is an online video-sharing and social media platform headquartered in San Bruno, California, United States. In chemistry education, instructors often produce video lectures and tutorials to explain complex concepts, conduct experiments, and solve problems. These videos can be uploaded to YouTube and integrated into the teaching platform (such as Google Classroom), making them readily accessible to students. Furthermore, YouTube can be leveraged to provide supplementary materials such as animations, simulations, and demonstrations to

enhance the learning experience. These materials can assist students in better understanding and visualizing abstract concepts in chemistry.

One practical approach for enhancing the learning experience of students in the Foundation Chemistry I course is to adapt an e-learning platform that utilizes Google Classroom and YouTube for online teaching. The course is designed for science and engineering students who are expected to learn about the conservation of mass, atomic interaction, and molecular structure to address the principles of physical chemistry. In addition, students are required to demonstrate proficiency in basic scientific skills related to physical chemistry while also upholding the values, attitudes, and professionalism expected in the field. Utilizing an e-learning platform like Google Classroom and YouTube can allow for a more interactive and engaging learning experience for students and provide them with access to a broader range of resources and materials to enhance their understanding of the subject matter.

To establish an online teaching environment for the Foundation Chemistry I course, the instructor began by creating a Google Classroom. This was accomplished by signing into their Google account and clicking on the '+' button to initiate the creation of a new class. In the process of creating the class, the instructor provided various details such as the class name (for instance, PI080S15), the section (Foundation Chemistry I), and a description for the semester, which included the start and end dates (in this case, August to December 2021). By creating this Google Classroom, the instructor could provide their students with a centralized location to access course materials, assignments, and other important information.

The course content for the Foundation Chemistry I class is meticulously organized into 14 weeks, each week covering a specific topic. The course begins with an in-depth understanding of matter and stoichiometry in week 1, followed by a comprehensive overview of the electronic structure of atoms, the periodic table, and periodicity in weeks 2 to 5. In weeks 6 to 9, the course delves into chemical bonding, while weeks 10 to 12 focus on the state of matter. In the course's final weeks, the students are introduced to thermochemistry, covering various topics such as enthalpy and Hess's law.

The course materials are available in the online classroom, including students' notes, tutorials, assignments, and relevant website links, including YouTube videos (Fig. 1). Furthermore, the course is conducted online, with classroom sessions, including lectures, lab, and tutorial sessions, conducted via Google Meet. These sessions are recorded to provide an archive for future reference and to help students who miss a session.

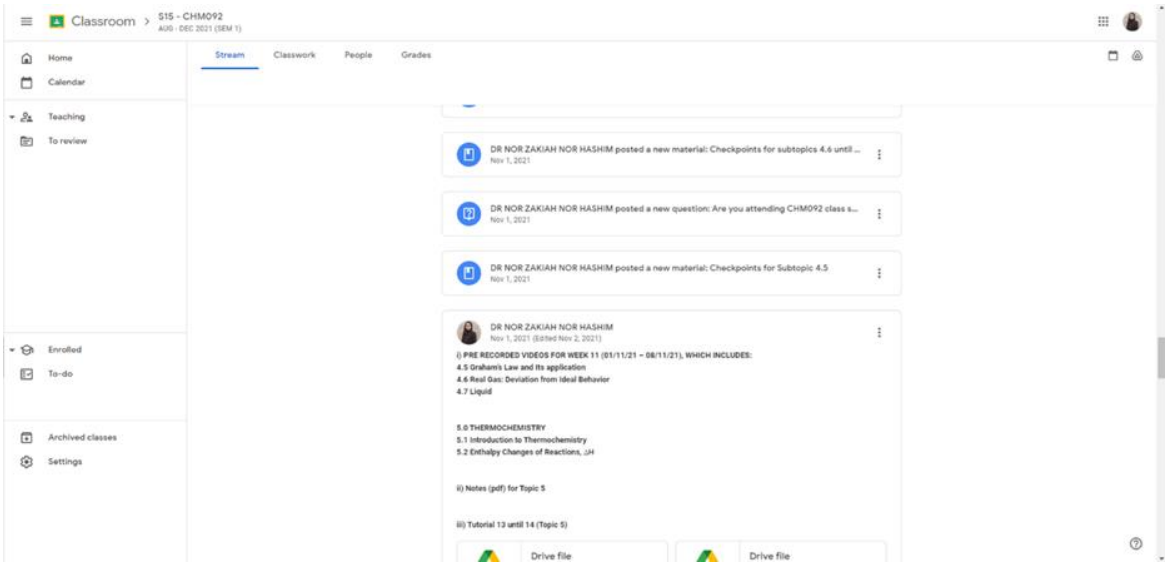


Fig. 1 The streamed course materials through Google Classroom

In Google Classroom, lecturers can easily share YouTube videos by posting the relevant links for each topic according to the assigned lesson plan of the course (Fig. 2). This feature adds value to the course as it allows students to access the videos easily and in the context of what they are learning.

The course lecturers have created and curated these videos, as found on YouTube, to supplement the course content, providing a better understanding of the topics covered in the class. The course materials and videos have been designed and developed with accessibility in mind to ensure that all students can access them. To make the videos more accessible, the lecturers have provided closed captions or transcripts for all the YouTube videos. Additionally, they have made sure that all the course materials are compliant with accessibility standards. This ensures that students with disabilities or impairments can access the course materials and videos with ease, without any barriers (Greenvall et al., 2021).

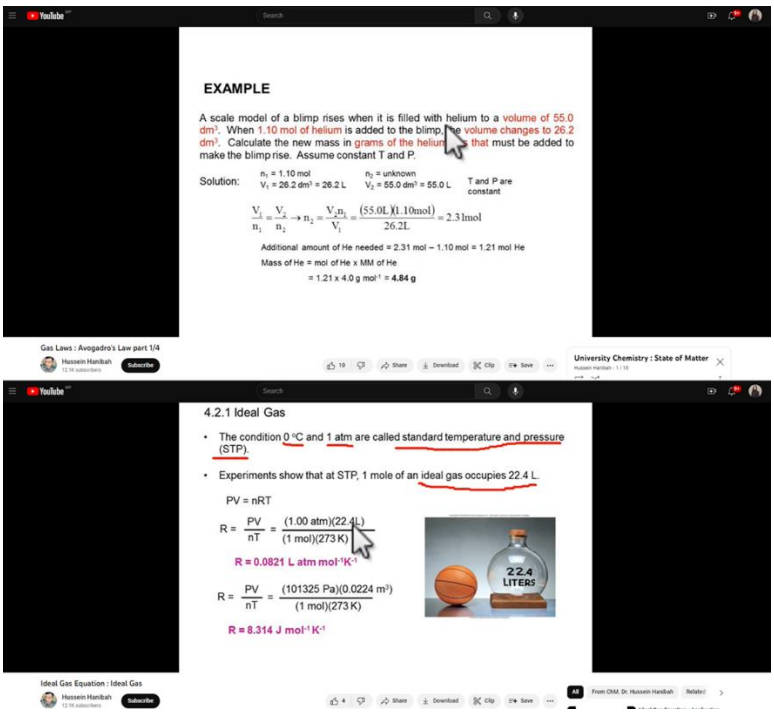


Fig. 2 A collection of chemistry lecture videos available on YouTube.

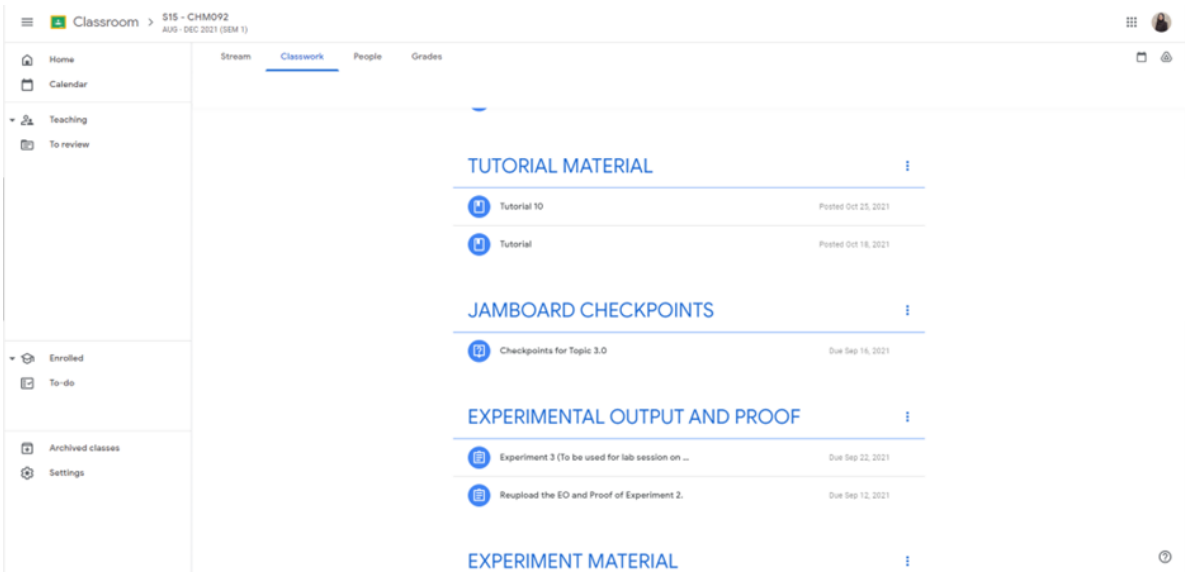
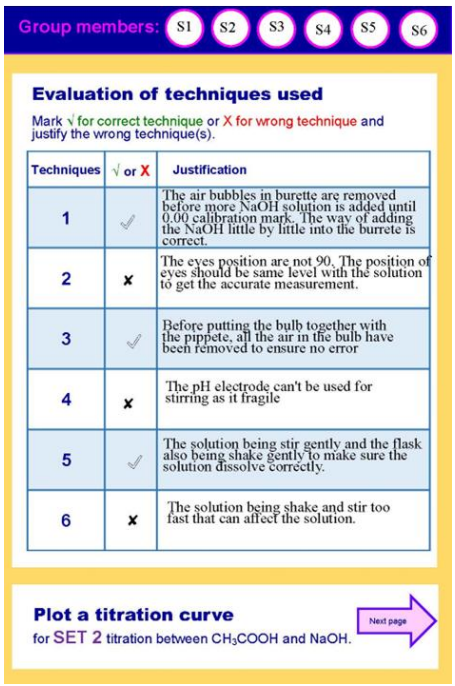


Fig. 3 Several useful features in Google Classroom are built into the platform.

Additionally, Google Classroom's built-in features, such as jamboard, enable students to participate in discussions and collaborate with their peers (Fig. 3). This creates a collaborative learning environment where students can pose questions, start discussions, and engage with each other. This approach to learning encourages active participation and fosters a sense of community among students, which is essential for effective learning.

For the Foundation Chemistry I online lab session, most of the chemistry lecturers opted for prerecorded experiments to demonstrate actual chemical experiments to the students. This approach has been highly effective in providing a visual aid and helps students understand the various procedures involved in conducting experiments. The experimental output (EO) for each experiment is also given to the students to test specific scientific skills. An example of this is shown in Fig. 4, which displays the sample of students' returned EO for the experiment of acid and base titration. The students are required to identify the correct and incorrect techniques for each of the procedures in the EO, which were earlier demonstrated in the prerecorded videos by the chemistry lecturers. This approach ensures that students can differentiate between the right and wrong techniques, thereby helping to maintain the quality of the experiment. Through this exercise, students are able to recognize and avoid common errors that may compromise the accuracy of their results. Moreover, understanding the correct techniques allows students to perform titrations more precisely, leading to more reliable and consistent data. As a result, analyzing the difference between the correct and incorrect techniques deepens students' understanding of the principles behind acid-base titrations, and helps them connect theory with practice.


Group members: S1 S2 S3 S4 S5 S6

Evaluation of techniques used

Mark √ for correct technique or X for wrong technique and justify the wrong technique(s).

Techniques	√ or X	Justification
1	✓	The air bubbles in burette are removed before more NaOH solution is added until 0.00 calibration mark. The way of adding the NaOH little by little into the burrete is correct.
2	✗	The eyes position are not 90. The position of eyes should be same level with the solution to get the accurate measurement.
3	✓	Before putting the bulb together with the pippete, all the air in the bulb have been removed to ensure no error
4	✗	The pH electrode can't be used for stirring as it fragile
5	✓	The solution being stir gently and the flask also being shake gently to make sure the solution dissolve correctly.
6	✗	The solution being shake and stir too fast that can affect the solution.

Plot a titration curve

for SET 2 titration between CH_3COOH and NaOH.

Next page

Fig. 4 The sample of students' returned EO for the acid and base titration experiment

Google Classroom is a robust and highly efficient tool that has revolutionized the way educators approach teaching and learning. It provides educators with a host of features that help them streamline their teaching processes, making it easier for them to manage their classes and provide high-quality education to their students. One of the most noteworthy features of Google Classroom is its ability to promote collaboration and communication between students and teachers, which fosters a more interactive and engaging learning environment.

RESULTS

Evaluating innovative teaching methods has become increasingly important in today's educational landscape (Haleem et al., 2022). Specifically, in the context of teaching foundational chemistry I in Malaysia, it is crucial to assess the effectiveness of modern tools such as YouTube and Google Classroom. These platforms offer unique opportunities for teachers to engage students in interactive learning experiences and provide valuable resources beyond traditional classroom instruction. By thoroughly evaluating these innovative teaching methods, educators can ensure that they are providing students with the best possible learning experiences and preparing them for success in an ever-evolving world (Tong et al., 2022).

When it comes to facilitating structured learning and assessment, Google Classroom holds a significant advantage over YouTube (Dash, 2019). Google Classroom's built-in tools make it easier to track learning outcomes and progress. On the other hand, YouTube is more versatile for visual learning, which can help students better comprehend complex concepts in chemistry.

In terms of engagement, YouTube's vast accessibility and visual appeal can enhance student engagement. The platform's multimedia content can pique students' interest, making it more likely for them to participate in the learning process. Meanwhile, Google Classroom's structured environment and built-in communication tools can promote sustained engagement with course materials and assessments. Students can easily access assignments and communicate with their instructors, which can lead to a more comprehensive understanding of the course content.

In order to analyse the various factors that influence success in teaching Foundation Chemistry I through YouTube and Google Classroom, it is essential to consider external factors such as access to technology, prior experience with online learning, demographic characteristics, socioeconomic status, learning preferences, geographic location, and language proficiency in greater detail (De Simone et al., 2022).

Access to technology is one of the key factors that can impact the success of online learning. Students with reliable access to computers, smartphones, and internet connectivity are more likely to engage with course content on YouTube and Google Classroom (Muthuprasad et al., 2021). On the other hand, students from regions with digital divides or those who have limited access to technology may face obstacles in participating fully in online classes, leading to disparities in learning outcomes (K. Jafar et al., 2023).

Prior experience with online learning is another significant factor that can influence student performance in online classes. Students with prior experience in online learning may have an advantage in adapting more easily to the online teaching methods employed through YouTube and Google Classroom (Butt et al., 2021). They may be more comfortable with digital tools and self-directed learning. In contrast, students who are new to online learning may face a steeper learning curve and require additional support and guidance to navigate the platforms effectively. This can impact their initial engagement and success in online classes.

Demographic characteristics such as age, gender, and educational background can also play a crucial role in how students approach online learning (Yu, 2021). Understanding the unique needs and preferences of different demographic groups can help tailor teaching methods to improve student outcomes. However, demographic disparities may exist, and older or non-traditional students may have different learning needs compared to younger, traditional students. Gender-related disparities in engagement and performance can also emerge, leading to unequal opportunities for success.

Socioeconomic status can significantly impact a student's ability to access technology and resources, which can affect their success in online classes (Gopal et al., 2021). Students from more affluent backgrounds may have access to better devices and internet connections, while students from lower socioeconomic backgrounds may face technology and resource limitations. This can lead to disparities in learning outcomes.

Learning preferences are another factor that can impact a student's engagement and success in online classes (Hollister et al., 2022). Students have varying learning preferences, and some may thrive in a self-paced, independent learning environment provided by YouTube, while others may benefit from the structured nature of Google Classroom. However, if the teaching method does not align with a student's preferred learning style, it can affect their engagement and success. Personalized approaches may be needed to accommodate these differences.

Geographic location can also influence students' access to resources and support, leading to disparities in learning outcomes. Urban students may have better access to high-speed internet and support services, while rural or remote students may face connectivity challenges (A. Jafar et al., 2022). This can impact their ability to participate in online classes and receive academic support.

Finally, language proficiency is critical in understanding course materials and can impact a student's ability to comprehend chemistry concepts presented on YouTube or Google Classroom. Students with strong language skills may have an advantage in comprehending course materials, while students with limited language proficiency may struggle with course materials presented in English or any other language (Abdulrahaman et al., 2020b). They may require additional support, translation, or language resources to achieve success in online classes.

The research design used to assess the impact of YouTube and Google Classroom in teaching Foundational Chemistry I involved a careful selection of participants from the science track. A total of 27 students, consisting of 9 boys and 18 girls, were chosen to participate in the study.

To gather the necessary information, a quiz was administered via Google Classroom, covering Topic 1 of the chemistry curriculum, namely Matter and Stoichiometry. This topic encompasses a range of subtopics, such as atomic structure and sub-atomic particle, atomic number, mass number and isotope, chemical formula, and IUPAC nomenclature of compounds, as well as balancing chemical equations. The quiz consisted of ten multiple-choice questions (MCQ) and was held on Thursday, August 26th, 2021, between 8:30 pm and 9:30 pm, lasting one hour. Each of the ten questions was valued at one mark, and the quiz aimed to test the understanding of the aforementioned subtopics in Topic 1.

Additionally, On Monday, December 6th, 2021, the final assessment for Foundational Chemistry I was held from 9:00 am to 12:00 pm. During this time, students were expected to complete the assessment, which consisted of two parts: Part A and Part B. Part A was worth 30 marks and consisted of 15 MCQ, while Part B consisted of 14 structured questions, worth a total of 70 marks. The assessment covered topics from Topic 2 to Topic 5, and students were required to answer questions from each of these topics. For Part B, students were tested on their knowledge of Topic 2 (questions 1 and 2), Topic 3 (questions 4 to 7), Topic 4 (questions 8 to 11), and Topic 5 (questions 12 to 14). To submit their answers, students were required to upload them via the link posted in Google Classroom. It was important that students completed the assessment within the given time frame and followed all the submission guidelines to ensure their work was marked accurately.

DISCUSSION

When it comes to assessing and grading students, lecturers have found Google Classroom to be a powerful tool. With its user-friendly interface, it allows them to create and manage assignments, quizzes, and tests with ease. They can set due dates, grading rubrics, and provide feedback to students in a timely manner. This not only saves time but also ensures that students are aware of their progress and have a clear understanding of their strengths and weaknesses.

Based on the statistical analysis presented in Fig. 5, it was found that students who took the online quiz through Google Classroom scored an average of 7.07 marks out of 10. The platform has proven to be an invaluable tool for both chemistry lecturers and students alike. Instructors who use Google Classroom can keep track of their students' academic progress. The platform enables teachers to view detailed reports on the learning outcomes of their pupils, track their attendance, and identify areas that require more attention.

The analysis revealed that the highest average score for a single question was 1 mark, which was obtained by 27 students for question number 9 (Table 1). This question required students to calculate the mole fraction based on the given molality and mass of the solvent. On the other hand, question number 2 had the lowest average score of 0.50 marks. This question required students to solve the atomic mass of an isotope based on the percentage abundance of available isotopes for the chemical elements. This particular question was categorized as cognitive Level 3 (C3) according to Bloom’s taxonomy, which tested the students' ability to apply their knowledge and analytical skills. The statistical analysis also showed that half of the class performed well in solving the problem. The students in the class have demonstrated a remarkable ability to learn and apply the knowledge and skills taught to them within a very limited timeframe of 48 minutes. By leveraging Google Classroom, educators are

able to enhance the quality of their teaching and provide their students with a more engaging and effective learning experience.

Table 1. The progress of online quiz conducted through Google Classroom

Question	Maximum possible score	Maximum score	Average score	Minimum score
1	1.00	1.00	0.88	0.00
2	1.00	1.00	0.50	0.00
3	1.00	1.00	0.54	0.00
4	1.00	1.00	0.83	0.00
5	1.00	1.00	0.83	0.00
6	1.00	1.00	0.58	0.00
7	1.00	1.00	0.83	0.00
8	1.00	1.00	0.58	0.00
9	1.00	1.00	1.00	1.00
10	1.00	1.00	0.54	0.00

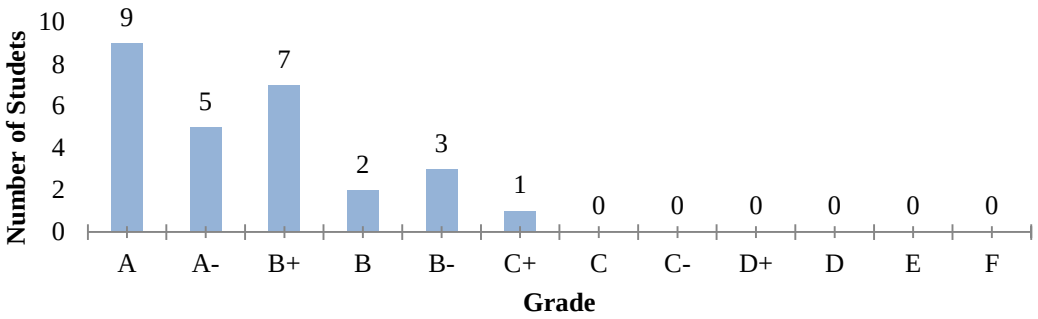


Fig. 5. The student's performance for final assessment according to grades.

In the final assessment (Fig. 5), a total of 27 students were evaluated. Out of these, 14 students performed outstandingly and achieved grades ranging from A- to A, while 12 students scored grades ranging from B- to B+. Only one student received a C+ grade, as indicated in Figure 6. The overall achievement of the class was remarkable, with a 100% pass rate. It is worth noting that half of the students successfully obtained excellent results, which is a testament to their hard work and dedication.

Overall, this impressive feat was made possible thanks to the various resources shared through Google Classroom, including online notes, prerecorded lectures, and tutorials. Google Classroom provides a platform for distributing quizzes, assignments, and assessments to students, which enables teachers to keep track of their progress and provide them with feedback on their performance. The continuous feedback loop created by these assessments keeps students actively engaged in the learning process, allowing them to track their progress, identify areas of improvement, and set goals.

The ability to monitor their performance and receive feedback at regular intervals is a vital motivator for students to stay engaged in their learning journey. Online resources, including the use of self-paced learning, is a key driver of student engagement. Students can progress through the material at their own speed, revisiting topics as needed. This flexibility allows them to explore the content thoroughly and comprehensively, enhancing their understanding and enthusiasm for the subject. The prerecorded lectures, in particular, offer a multimodal learning experience that caters to different learning preferences. The combination of visual and auditory elements in these lectures makes complex topics, such as calculations in matter and stoichiometry, more accessible to students.

The lecturers in charge of the online Foundation Chemistry I course have actively sought student feedback to improve the course continuously. They consider every piece of feedback seriously and use it to adjust the course content and teaching methods. This ensures that the students receive the best possible learning experience.

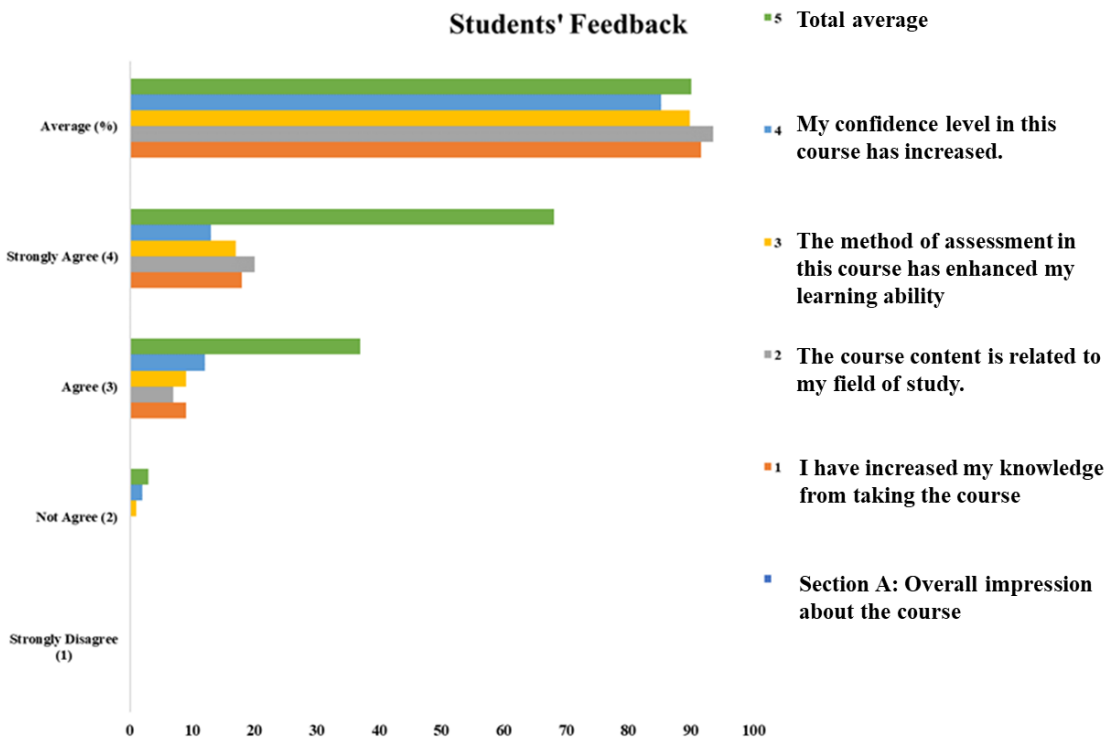


Fig. 6 Student's feedback.

According to the recent report in Fig. 6, out of the 27 students who enrolled in the course, the majority of them have experienced a significant increase in their knowledge. Around 91.67% of students have reported seeing an improvement in their knowledge from taking the course. Moreover, 93.52% of students have found that the course content is relevant to their field of study, which is crucial for students as it helps to link theoretical knowledge with practical skills.

The method of assessments in the course has also been praised by the students. Around 89.81% of students have found that the assessment method has enhanced their learning ability, which is great news for the lecturers as it shows that the course is designed to help students retain the knowledge they have learned.

Additionally, the confidence level of students taking the course has also increased. About 85.19% of students have reported a boost in their confidence level while taking the course, which is a significant achievement for the lecturers as it is crucial for students to feel confident in their abilities.

In general, the course has received positive feedback from the students. On average, around 90.05% of students have agreed with the overall impression of the course, which indicates that the course is well-designed, structured, and executed. When it comes to student satisfaction, individual preferences play a significant role. Some students might prefer the interactivity and multimedia content of YouTube, while others may appreciate the organization and assessment features of Google Classroom. Ultimately, the choice between the two platforms will depend on the specific needs and preferences of each student.

By closely evaluating the effectiveness of their teaching methods and content, the chemistry lecturers are able to provide students with an ever-improving learning experience. They are constantly striving to improve their teaching methods and course content, with the ultimate goal of providing

students with a more comprehensive and effective learning experience. The lecturers' commitment to continuous improvement is a testament to their dedication to their students' success.

IMPLICATION OF FINDINGS

During the assessment process, it is important to consider the limitations that may affect the results. For instance, in this study, the sample size only included 27 students from the science track. This small sample size may not represent the entire population of science students, and the engineering students, who generally have more boys, may perform differently. Therefore, it is essential to acknowledge the potential limitations of the sample size in interpreting the results.

Furthermore, in the study conducted, it was observed that the accessible learning environment for students with diverse learning needs was not extensively investigated, which is a crucial aspect to consider when developing an inclusive online learning environment. To create a supportive and inclusive learning environment that caters to the needs of all students, it is essential to comprehend the difficulties that students with diverse learning needs confront. Therefore, it is imperative to thoroughly study the accessible learning environment to provide a genuinely inclusive learning experience for all students.

CONCLUSION

The choice between YouTube and Google Classroom depends on the specific educational goals and preferences of the instructor and students. Combining the strengths of both platforms can provide a holistic and effective approach to teaching Foundational Chemistry I in Malaysia, addressing the diverse learning needs of students. This diversity in presentation styles engages a broader spectrum of students who respond better to various forms of content delivery. Furthermore, the recorded versions of the lectures shared on YouTube were also helpful in guiding the students towards solving questions related to calculations in matter and stoichiometry. The recorded versions of lectures shared on YouTube play a vital role in enhancing engagement levels. They serve as a valuable resource for students seeking further clarification. Students can revisit specific sections of the lecture to reinforce their understanding, which is especially beneficial for complex subjects like matter and stoichiometry. The ability to review content and seek clarification contributes to higher engagement levels, as students feel more confident in their comprehension and problem-solving skills. In this study, a group of twenty-seven students was evaluated, and the results were highly encouraging. Out of the group, fourteen students performed exceptionally well, achieving grades ranging from A- to A. Additionally, twelve students achieved grades ranging from B- to B+. Only one student received a C+ grade. It is noteworthy that the entire class achieved an overall 100% pass rate, which is a testament to the students' commitment and hard work. The fact that half of the students received excellent results in their final assessment is a remarkable accomplishment that underscores the effectiveness of the teaching methodology employed.

The practical implications of incorporating online teaching methods through Google Classroom and YouTube for foundational Chemistry I in Malaysia are significant, and they can benefit both educators and institutions. In summary, adopting online teaching methods via Google Classroom and YouTube for foundational Chemistry I in Malaysia presents a host of opportunities but also comes with challenges. To ensure success, educators and institutions should prioritize accessibility, training, quality content, technical support, data security, assessment, feedback, and adaptation. Cultural sensitivity and linguistic diversity should be recognized, and a hybrid approach can be considered to accommodate different learning needs. Through careful planning and investment, online teaching can be a powerful tool for delivering quality education in Malaysia while addressing the challenges associated with traditional classroom-based instruction.

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