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Determining the Impact of Active Learning Strategies on Success Rate in Higher Education

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ABSTRACT

For decades, lecturers have been dedicated to exploring innovative methods that enhance student learning and foster academic success. This commitment to continuous improvement creates a dynamic and engaging educational environment. This study aims to provide a comprehensive understanding of the effects of active learning on student performance in higher education. This study was conducted at the University of Venda's Department of Food Science and Technology, part of the Faculty of Science, Engineering, and Agriculture. In this mixed-methods study, participants took part in in-depth interviews to discuss their experiences, perspectives, and challenges related to the implementation and participation in active learning. The participant group consisted of 5 males and 10 females. Data collection tools included a questionnaire, a tape recorder, and a notebook. Descriptive statistics were used to analyse the quantitative data. The findings demonstrate that the teaching strategies employed by the instructors significantly highlight the effectiveness of active learning in higher education. Moreover, the results emphasise the importance of regularly evaluating student performance in each module. It was also evident that a passing grade does not necessarily indicate student satisfaction with the lectures or practical components of the course. Consequently, these findings contribute meaningfully to academic discourse and provide practical implications for instructors, aiding them in developing more effective teaching strategies.

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INTRODUCTION

Instructors, teachers, and lecturers are dedicated to exploring innovative strategies aimed at enhancing student learning and fostering academic excellence.[1] A key aspect of this endeavour is the active involvement of students in their own educational journey through a variety of engaging activities. These activities include hands-on laboratory work, dynamic group discussions, collaborative problem-solving exercises, group assignments, and in-depth case studies. Active learning, characterised as a student-centred pedagogical approach, has gained significant traction among educators in recent years due to its effectiveness in promoting deeper comprehension and retention of material.[2]

[1] Elizabeth F Barkley and Claire H Major, *Student Engagement Techniques: A Handbook for College Faculty* (John Wiley & Sons, 2020).
[2] Cynthia Cummings et al., "Active Learning Strategies for Online and Blended Learning Environments," in *Models for Improving and Optimizing Online and Blended Learning in Higher Education* (IGI Global Scientific Publishing, 2015), 58–82; Joanna Jesionkowska, Fridolin Wild, and Yann Deval, "Active Learning Augmented Reality for STEAM Education—A Case Study," *Education Sciences* 10, no. 8 (2020): 198.

This approach stands in stark contrast to traditional lecture-based teaching, which has often been criticised for its passive nature and its tendency to encourage surface-level learning rather than fostering a deeper understanding of concepts.[3] Research comparing these different teaching methodologies consistently highlights that students are more inclined to favour active learning environments, where their participation is not only encouraged but essential to their success.[4]

Moreover, numerous studies have demonstrated that active learning not only enhances students' engagement but also significantly improves their critical thinking skills.[5] This study specifically aims to provide a thorough understanding of how active learning methodologies affect student performance in Food Science and Technology modules, with a particular emphasis on the subfield of Food Chemistry. By investigating various metrics, such as pass rates, overall academic achievement, students' ability to apply their knowledge to solve practical, real-world problems, and their graduation rates, this research seeks to fill a current gap in the literature regarding the effectiveness of active learning in this specialised context.

The findings of this study will not only contribute to the broader academic discourse but also offer practical implications for educators. In understanding how active learning can be harnessed to improve educational outcomes, instructors and lecturers will be better equipped to develop and implement more effective pedagogical strategies that truly resonate with students and support their learning journey.

Research Objectives

1. Determine the relationship between student academic achievement and active learning strategies in the Food Chemistry Module.
2. Evaluate how various forms of active learning, such as case studies, group discussions, problem-solving activities, and flipped classrooms, influence student success in the Food Chemistry module.
3. Identify specific student characteristics, including prior academic performance, learning style, and demographic factors, which may moderate the impact of active learning on student success.

Research Questions

1. How can active learning improve the food chemistry module's success rate among the Department of Food Science and Technology students?

LITERATURE REVIEW

Active learning is a teaching strategy that promotes student engagement rather than passive listening during lectures, as noted by Cho.[6] This approach includes various instructional strategies, such as peer education, group discussions, problem-based learning, cooperative projects, and flipped classrooms, among others.[7] Higher retention rates, greater engagement, and better understanding are the three key advantages of active learning. Increased student involvement has repeatedly been linked to active learning practices. Students are more likely to remain attentive and actively participate in the learning process when actively engaging in conversations, problem-solving, or hands-on activities.[8] Active

[3] Besa Dogani, "Active Learning and Effective Teaching Strategies," *International Journal of Advanced Natural Sciences and Engineering Researches* 7, no. 4 (2023): 136–42.

[4] Adelheid A M Nicol et al., "Comparison of High-Technology Active Learning and Low-Technology Active Learning Classrooms," *Active Learning in Higher Education* 19, no. 3 (2018): 253–65.

[5] Yoko Kusumoto, "Enhancing Critical Thinking through Active Learning," *Language Learning in Higher Education* 8, no. 1 (2018): 45–63; N Morze et al., "Implementation of Adaptive Learning at Higher Education Institutions by Means of Moodle LMS," *Journal of Physics: Conference Series* 1840, no. 1 (March 1, 2021): 012062, https://doi.org/10.1088/1742-6596/1840/1/012062; J. C. Bean and D. Melzer, *Engaging Ideas: The Professor's Guide to Integrating Writing, Critical Think*, 2021.

[6] Hyun Jin Cho et al., "Active Learning through Flipped Classroom in Mechanical Engineering: Improving Students' Perception of Learning and Performance," *International Journal of STEM Education* 8, no. 1 (2021): 46.

[7] Claudio Fazio et al., "Strategies for Active Learning to Improve Student Learning and Attitudes towards Physics," in *Teaching-Learning Contemporary Physics: From Research to Practice* (Springer, 2021), 213–33.

[8] Celeste A Wheat et al., "Active University Teaching and Engaged Student Learning: A Mixed Methods Approach.," *Journal of the Scholarship of Teaching and Learning* 18, no. 4 (2018): 28–50.

learning encourages a deeper understanding of the course material. Students are urged to apply knowledge, think critically, and analyse information. Critical thought, information analysis, and knowledge application to practical situations are all promoted in the classroom. According to Freeman, active learning leads to better comprehension and frequently leads to improved academic performance. According to the literature, active learning strategies may increase retention rates. When actively involved in their learning, students are more likely to finish their courses and stay enrolled.[9]

Impact of active learning on student success in different modules

The impact of active learning on student success rates in modules, particularly in the context of higher education, is a multifaceted issue that has garnered significant attention from educators and researchers alike.[10] Active learning has positively impacted student success rates across various modules and disciplines.[11] One of the key advantages of this approach is its ability to increase the pass rate in modules by engaging students in more meaningful and interactive learning experiences.[12] Unlike passive listening in lecture-based formats, active learning encourages students to apply their knowledge, improving their ability to retain information and understand complex concepts.

A meta-analysis of 225 research studies conducted by Freeman et al. found that students in active learning classrooms outperformed their peers in traditional lecture-based classrooms in terms of test scores and course completion rates.[13] Active learning has also been associated with increased critical thinking skills. When students engage in problem-solving exercises and collaborative projects, they are more likely to develop analytical skills that can be applied in various academic contexts.[14] Many studies have documented the positive feedback students provide on active learning strategies. Students frequently cite active learning techniques as a reason they are more satisfied with their courses, noting a greater level of interest and participation.[15]

Food Chemistry module

The Food Chemistry module is at the heart of exploring the chemical underpinnings of food, from its composition to its nutritional value and safety.[16] This vital discipline within food science and technology equips students with the foundational principles and practical applications of chemistry in the context of food. Central to the Food Chemistry module is the comprehensive study of the essential constituents of food and their behaviour under diverse conditions.[17] This subject often covers food additives, flavours, and the intricate chemistry behind food preservation and processing techniques. Understanding these chemical processes is crucial to developing safe, nutritious, and high-quality food products.

In recent years, a notable shift has been towards more engaging and interactive teaching methods, particularly through active learning.[18] This pedagogical approach, which includes group discussions, problem-solving tasks, and case studies, enhances students' comprehension of complex concepts and fosters critical thinking, collaboration, and practical application of theory.[19] Certainly, integrating active learning into modules like Food Chemistry brings its own set of challenges. Bridging

[9] Scott Freeman et al., "Active Learning Increases Student Performance in Science, Engineering, and Mathematics," *Proceedings of the National Academy of Sciences* 111, no. 23 (2014): 8410–15.
[10] Susanna Hartikainen et al., "The Concept of Active Learning and the Measurement of Learning Outcomes: A Review of Research in Engineering Higher Education," *Education Sciences* 9, no. 4 (November 19, 2019): 276, https://doi.org/10.3390/educsci9040276.
[11] Freeman et al., "Active Learning Increases Student Performance in Science, Engineering, and Mathematics."
[12] Quan Nguyen et al., "Examining the Designs of Computer-Based Assessment and Its Impact on Student Engagement, Satisfaction, and Pass Rates," *Computers in Human Behavior* 76 (2017): 703–14.
[13] Freeman et al., "Active Learning Increases Student Performance in Science, Engineering, and Mathematics."
[14] Cherine Jackson, "Natural and Life Sciences Teachers' Affective Development during an Indigenous Knowledge Professional Development Intervention" (North-West University, 2019).
[15] Sneha Tharayil et al., "Strategies to Mitigate Student Resistance to Active Learning," *International Journal of STEM Education* 5, no. 1 (2018): 7.
[16] Ian C Shaw, *Food Safety: The Science of Keeping Food Safe* (John Wiley & Sons, 2018).
[17] Tom Coultate, *Food: The Chemistry of Its Components* (Royal Society of Chemistry, 2023).
[18] Amy Roehl, Shweta Linga Reddy, and Gayla Jett Shannon, "The Flipped Classroom: An Opportunity to Engage Millennial Students through Active Learning Strategies," *Journal of Family and Consumer Sciences* 105, no. 2 (2013): 44.
[19] Irit Sasson, Itamar Yehuda, and Noam Malkinson, "Fostering the Skills of Critical Thinking and Question-Posing in a Project-Based Learning Environment," *Thinking Skills and Creativity* 29 (2018): 203–12.

knowledge from prior education, such as chemistry in grade 12, to specialised applications in food chemistry can be demanding. Students often find the module challenging due to the abstract nature of chemical reactions and the need to comprehend intricate molecular processes.

However, these challenges serve as opportunities for innovative teaching. Teachers/lecturers can enhance student engagement and understanding by creating an environment that promotes active participation and real-world problem-solving. This, in turn, could lead to improved academic achievement, retention rates, and better preparation for food science and technology careers.

Relationship Between Active Learning and Academic Achievement

Active learning and academic achievement are closely intertwined, with numerous studies suggesting that active learning strategies can significantly enhance students' academic performance.[20] Active learning, characterised by student engagement in activities such as group discussions, problem-solving tasks, and case studies, shifts the focus from passively receiving information to actively participating in learning.[21] This method promotes critical thinking, collaboration, and the application of knowledge in practical contexts, which are key components of deep learning.

Active learning makes students more likely to retain information, understand complex concepts, and apply knowledge in new situations.[22] This engagement is critical in subjects like Food Chemistry, where understanding complex chemical reactions and processes is essential. Applying active learning strategies can lead to a higher pass rate in challenging modules, improved academic achievement, and a greater ability to tackle real-world problems.[23] Active learning has proven particularly successful in science, technology, engineering, and mathematics (STEM). For instance, Deslauriers et al. discovered that active learning physics course students performed better on concept exams than in a traditional classroom.[24] Furthermore, active learning caters to diverse learning styles and can be particularly beneficial in fostering an inclusive educational environment where all students, regardless of their background, can succeed.

The relationship between active learning and academic achievement is also evident in the positive outcomes of active learning, such as increased motivation, engagement, and holistic development.[25] These outcomes contribute to a more engaging and effective learning experience, which improves academic performance. However, it is important to note that the success of active learning strategies can be influenced by numerous factors, including the implementation approach, the instructor's role, and the student's readiness to engage in active learning. Therefore, understanding and addressing these factors is crucial in maximising the benefits of active learning for academic achievement.

Influence of Different Forms of Active Learning and the Moderating Role of Student Characteristics

There are many active learning strategies, and the one used can affect how well students perform academically. Three primary active learning approaches are highlighted in the literature as having an impact. Collaborative learning, in which students work together on tasks or problem-solving exercises, has been found to improve critical thinking abilities and academic accomplishment.[26] Problem-based learning (PBL) is an organised, active learning method where students work on issues from the real

[20] Marco Seeber et al., "Self-Citations as Strategic Response to the Use of Metrics for Career Decisions," *Research Policy* 48, no. 2 (March 2019): 478–91, https://doi.org/10.1016/j.respol.2017.12.004.

[21] Peter White, "The Concept of Diseases and Health Care in African Traditional Religion in Ghana," *HTS: Theological Studies* 71, no. 3 (2015): 1–7.

[22] Jeffrey D Karpicke, "Retrieval-Based Learning: Active Retrieval Promotes Meaningful Learning," *Current Directions in Psychological Science* 21, no. 3 (2012): 157–63.

[23] Wondifraw Dejene, "The Practice of Modularized Curriculum in Higher Education Institution: Active Learning and Continuous Assessment in Focus," *Cogent Education* 6, no. 1 (2019): Research-Article.

[24] Annie Deslauriers et al., "A Three-Step Procedure in SAS to Analyze the Time Series from Automatic Dendrometers," *Dendrochronologia* 29, no. 3 (January 2011): 151–61, https://doi.org/10.1016/j.dendro.2011.01.008.

[25] Arnold B Bakker, Evangelia Demerouti, and Lieke L Ten Brummelhuis, "Work Engagement, Performance, and Active Learning: The Role of Conscientiousness," *Journal of Vocational Behavior* 80, no. 2 (2012): 555–64.

[26] Idi Warsah et al., "The Impact of Collaborative Learning on Learners' Critical Thinking Skills," *International Journal of Instruction* 14, no. 2 (2021): 443–60.

world. According to studies, PBL can increase academic achievement and foster a deeper grasp of the course material.[27] According to the flipped classroom concept, students individually examine course material before class and participate in active learning exercises during that time. According to research, the flipped classroom strategy can boost academic attainment.[28]

Different student characteristics, such as prior knowledge, learning style, and motivation, can moderate the impact of active learning on academic achievement.[29] Active learning may have varied results for students with distinct levels of prior knowledge, with those with stronger subject backgrounds having an edge over others.[30] Students have a variety of learning preferences, including those that are visual, aural, or kinesthetic. To ensure that activities fit students' learning preferences, instructors should consider these distinctions when adopting active learning.[31] The efficiency of active learning can be influenced by student motivation. When compared to less driven pupils, initiative-taking students may be more engaged and obtain greater achievements, while less motivated students may require additional support.[32]

Challenges and opportunities of active learning in different modules

Although active learning has many benefits, it can be difficult for teachers and students. Active learning activities may require more time from instructors to prepare and facilitate. Students may initially resist these techniques if used in passive learning environments.[33] Furthermore, despite its advantages, active learning is not frequently used in higher education because it lacks the necessary resources, time, or expertise to carry out active learning. Additionally, the administrative support staff are insufficient to facilitate active learning.[34] The adoption of active learning in higher education might be difficult since it requires adjustments to course design, faculty development, and institutional support, according to a review of the literature by Hartikainen et al.[35]

The effect of active learning on students' progress in higher education has been the subject of numerous studies. According to Khan et al, active learning significantly improved student performance in physics at the secondary school level in Pakistan.[36] According to Freeman et, research has shown that active learning improves student science, engineering, and mathematics performance.[37] In higher education, Jääskelä and Nissilä discovered that active learning had a favourable effect on student engagement and motivation.[38]

According to research, active learning helps students succeed in higher education. However, implementing active learning can be difficult because faculty development, course design improvements, and institutional support are required. More studies are required to determine the best techniques for implementing active learning in higher education and to overcome the implementation hurdles.

THEORETICAL FRAMEWORK

[27] John R Savery, "Overview of Problem-Based Learning: Definitions and Distinctions," *Essential Readings in Problem-Based Learning: Exploring and Extending the Legacy of Howard S. Barrows* 9, no. 2 (2015): 5–15.
[28] Lanqin Zheng et al., "The Effectiveness of the Flipped Classroom on Students' Learning Achievement and Learning Motivation," *Journal of Educational Technology & Society* 23, no. 1 (2020): 1–15.
[29] Mazuin Mat Halif et al., "Moderating Effects of Student Motivation on the Relationship between Learning Styles and Student Engagement.," *Asian Journal of University Education* 16, no. 2 (2020): 94–103.
[30] Katelyn M Cooper, Virginia R Downing, and Sara E Brownell, "The Influence of Active Learning Practices on Student Anxiety in Large-Enrollment College Science Classrooms," *International Journal of STEM Education* 5, no. 1 (2018): 23.
[31] Doug Lombardi et al., "Astronomy Team, Biology Team, Chemistry Team, Engineering Team, Geography Team, Geoscience Team, and Physics Team.(2021). The Curious Construct of Active Learning," *Psychological Science in the Public Interest* 22, no. 1 (n.d.): 8–43.
[32] Deslauriers et al., "A Three-Step Procedure in SAS to Analyze the Time Series from Automatic Dendrometers."
[33] Tharayil et al., "Strategies to Mitigate Student Resistance to Active Learning."
[34] Tharayil et al., "Strategies to Mitigate Student Resistance to Active Learning."
[35] Hartikainen et al., "The Concept of Active Learning and the Measurement of Learning Outcomes: A Review of Research in Engineering Higher Education."
[36] R. Khan, " Interfaith Competition and Social Dynamics in Urban Ghana," *Journal of African Social Sciences* 18, no.3 (2017): 34–52.
[37] Jamal Alnsour et al., "The Impact of Urbanization on Cultural Heritage Buildings in Jordan: As-Salt as a Case Study," *Future Cities and Environment* 9, no. 1 (2023).
[38] T. Reddy, *South Africa's Insurgent Citizens: Disruptive Politics and Democratic Deepening* (Jacana Media, 2015).

Constructivism

Jean Piaget's (1896- 1980) work on educational psychology influenced the initial idea of constructivism. Constructivism is an educational theory that posits that learners actively construct their own knowledge and understanding through personal experiences and reflective processes. This theory contrasts sharply with traditional educational models, where students are often regarded as passive recipients of information, merely absorbing what is presented to them. Instead, constructivism emphasises that learning is an active and dynamic process, in which individuals derive meaning from their unique experiences and interactions with the world around them. Active learning strategies are essential to facilitate this knowledge construction. Techniques such as problem-based learning, collaborative group projects, and in-depth discussions not only engage students directly with the material but also encourage them to make meaningful connections between new information and their existing knowledge and experiences. For example, in problem-based learning, students tackle real-world challenges, prompting them to apply theoretical concepts to practical situations, which enhances their understanding and retention of the subject matter. By creating an environment that promotes exploration, experimentation, and participation, active learning strategies cultivate critical thinking skills and lead to a deeper understanding of the material. This shift from rote memorisation to meaningful sense-making allows learners to internalise knowledge and apply it in diverse contexts, fostering a more profound and lasting educational impact.

The researchers used this theory, as active learning strategies are essential to improve student engagement and understanding through experiential learning techniques. These techniques, including simulations, case studies, and hands-on activities, provide students with the opportunity to engage in Tangible Experiences. Students participate in real-world scenarios where they can apply theoretical concepts, allowing them to connect classroom learning with practical applications. For instance, simulations might depict complex environments, enabling learners to make decisions based on realistic circumstances. Reflect on Their Experiences for Deeper Insights: After participating in these activities, students are encouraged to reflect on their actions and outcomes. This reflective practice helps them analyse what worked, what did not work, and why, contributing to a richer understanding of the subject matter. Develop Abstract Concepts and Generalisations: Through discussions and reflective exercises, students can identify patterns and principles that emerge from their experiences. By synthesising these observations, they formulate abstract concepts that can be applied to new situations. Test Their Understanding Through Active Experimentation: Students are given the chance to take risks and experiment. By implementing their abstract concepts in practical scenarios, they can monitor their effectiveness, adjust their strategies as needed, and reinforce their learning through trial and error.

METHODOLOGY

Research Design

This study was an action research design in line with the report of Kemmis et al.[39] The study was conducted at the University of Venda, Department of Food Science and Technology, Faculty of Science, Engineering and Agriculture. The action research design helped to know how the students can relate the chemical composition of food to good health (my ontological assumption through questionnaire), their underlying beliefs and principles regarding food chemistry as a module (epistemological assumption through the interview), and how important is ethic, practice and decision making is affecting or will affect them (axiological assumption through the interview).

Research Approach

The research used a mixed methods approach to ensure a complete investigation of the subject. This involved quantitative and qualitative methods, according to Creswell.[40] The mixed-methods approach provides a comprehensive view of how active learning affects student achievement in the Food

[39] Stephen Kemmis, "Action Research as a Practice-based Practice," *Educational Action Research* 17, no. 3 (September 2009): 463–74, https://doi.org/10.1080/09650790903093284.

[40] John W. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 4th ed. (Thousand Oaks, CA: Sage Publications, 2014).

Chemistry module. Quantitatively, a survey (questionnaire) was used to collect the data. The survey evaluates several aspects of active learning, including the frequency with which lectures employ active learning techniques, students' views of engagement, academic success, and demographic data. For qualitative research, participants were subjected to an in-depth interview. The method investigated the experiences, perspectives, and difficulties of implementing and engaging in active learning.

The eclectic-mixed methods-pragmatic paradigm is the most recent paradigm to emerge in the postmodernist era.[41] The name refers to its openness to borrowing the methods of the other three paradigms to collect information and solve complex problems. Within this paradigm, "mixed methods research is formally defined as the class of research in which the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts, or language into a single study".[42]

Population and Sampling

The participants in this study consisted of undergraduate students enrolled on the Food Chemistry module in the Department of Food Science and Technology at the Faculty of Science, Engineering and Agriculture, University of Venda. Participants (students) were recruited and informed about the study through announcements in the Food Chemistry module. Fifteen (15) students participated in this study. The study was conducted within the Department of Food Science and Technology lecture hall, Faculty of Science, Engineering and Agriculture, University of Venda, where different active learning strategies are implemented.

Data Collection and Data Phases

The systematic and well-documented method of collecting data was used for this study to ensure that the information is accurately collected, analysed, and interpreted at every stage of the study. Data collection instruments were a questionnaire, a tape recorder, and a notebook. There are two data types for each cycle. The first was the exploratory phase. In this phase, I observed and analysed the module contents to identify the prevalence of active learning. Since the total number of students offering my module was small (15 students), all of the students participated in the study. Questionnaires (Appendix 1) were used to understand student perceptions of the effectiveness of active learning. The questionnaire was given to all students who wanted to participate in the study and who were comfortable with the questionnaire. In phase two of the study, an interview was used to investigate the students' experiences with active learning in the Food Chemistry modules**.** The students who indicated that an interview was their mode of participation in the study and felt safe were interviewed. The interview questions (Appendix 2) were structured to capture some of the objectives of this study. Data were collected from 10 August to 10 September 2024.

Action Research Cycle Stages

In the context of this study conducted at the University of Venda, within the Department of Food Science and Technology, the action research cycle stages are understood as a systematic and iterative process aimed at improving and refining the pass and graduation rates of students enrolled in the Food Chemistry module. Based on the provided information and the general principles of action research, the stages of this study adhere to the action research framework.

Data Analysis

In research to determine the impact of active learning on the success rate in the Food Chemistry Module, content analysis, reflective notes, and observation writing were used as a qualitative analysis method

[41] Valerie J. Caracelli and Jennifer C. Greene, "Crafting Mixed-method Evaluation Designs," *New Directions for Evaluation* 1997, no. 74 (June 8, 1997): 19–32, https://doi.org/10.1002/ev.1069; Innocent Zitha, Mokgaetji Georgina Mokganya, and Tshidaho Manyage, "Integration of Blended Learning in the Advent of COVID-19: Online Learning Experiences of the Science Foundation Students," *Education Sciences* 13, no. 7 (July 11, 2023): 704, https://doi.org/10.3390/educsci13070704.

[42] R.B. Johnson and A.J. Onwuegbuzie, "Mixed Methods Research: A Research Paradigm Whose Time Has Come," *Educational Researcher* 33, no. 7 (2004): 17.

to process and interpret the data collected through interviews.[43] These methods systematically examine text-based data to find patterns, topics, and groupings. A thorough examination of the experiences and viewpoints of students regarding the impact of active learning in the Food Chemistry module was made possible.

Descriptive statistics were used to analyse quantitative data sets as described by Mishra et al.[44] The results were analysed according to descriptive statistics, where tables, graphs, frequencies, and percentages were applied to summarise the responses into meaningful results. The Analysis of variance was applied to test the difference in the response results between the correct and the incorrect answers. The IBM SPSS 25 was used to analyse the quantitative data.

The audio tapes were transcribed verbatim immediately after collecting the qualitative data. The researchers utilised Tesch's eight steps of coding, according to Creswell and Creswell.[45] The total list was categorised, and an independent coder received a copy of the transcript for evaluation.

Ethical Considerations

The research proposal was submitted to the Research Ethics Committee of the University of Johannesburg. The ethical certificate obtained from the University of Johannesburg was used for this study. All participants signed an informed consent form before participating in the study. The participants were informed that participation is completely voluntary and that leaving at any point would not have any negative effects. In this study, a mixed method was used. This involved quantitative and qualitative methods, according to Creswell. [46] The mixed-methods approach provides a comprehensive view of how active learning affects student achievement in the Food Chemistry module. The strictest confidentiality standards were upheld. All data collected were anonymised to ensure participant privacy, and a special identity code was allocated.

PRESENTATION OF FINDINGS AND DISCUSSION

Demographic data

The respondents' ages suggest that most respondents were between the ages of 21-22. There were 5 male respondents, who made up 33%, and 10 females, making up 67%. These data show that most of the respondents were female, and all were in their final year (fourth year of study). Having a larger number of females than males in the class is in line with the belief of many people that the field of Food Science and Technology is meant for females rather than males.[47]

There were good responses from the respondents regarding the students' perception of active learning. From the question asked, "Do you know what active learning is?" 80% of the respondents (12 out of 15) reported knowing what "active learning" is. 20% (3 out of 15) were unsure or did not know. This implies some familiarity with active learning among the respondents, but there is room for clarification or education for the minority who are unsure. This is positive, as prior knowledge can enhance the adoption and effectiveness of active learning strategies. For the second question asked under the student's perception of active learning, "Does the food chemistry module use active learning methods?" 80% of the respondents believed the module uses active learning, while 20% were unsure. The uncertain responses may be from the respondents repeating the modules since the researchers were not the module coordinators in the past. It was important for the researchers to first introduce the teaching technique they wanted to use at the beginning of the lecture, especially to the students who had failed the module before the researchers the coordinators.

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[43] Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*.

[44] Prabhaker Mishra et al., "Descriptive Statistics and Normality Tests for Statistical Data," *Annals of Cardiac Anaesthesia* 22, no. 1 (2019): 67, https://doi.org/10.4103/aca.ACA_157_18.

[45] John W Creswell and J David Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (Sage publications, 2017).

[46] Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*.

[47] Rene Pearce et al., "Project-Based Learning for Promotion of Entrepreneurial Education among First Level Science Students," *International Journal of Research in Business and Social Science (2147- 4478)* 14, no. 1 (February 25, 2025): 151–59, https://doi.org/10.20525/ijrbs.v14i1.3820.

A similar response was received from the respondents on the third question, which asked about their perception of active learning in the food chemistry module. "How do you describe your overall perception of active learning in the food chemistry module?" Three (3) students, who comprise 20% of the respondents, were neutral, while twelve (12) students described their overall perception of active learning in the module as effective. This response may be attributed to both repeated and normal students in the module. The act of failing the module for the first time may contribute to a lack of interest in something new in teaching the module by the new module coordinator. Mokganya and Zitha reported that failure reduces students' interest or learners in a module due to fear and other factors.[48]

Table 1: Perceptions of Students on active learning in the Food Chemistry module

Variables		**Number (%) of respondents (*n*=15)**
Demographic information		
Age	21-22	12 (80)
	23-24	3 (20)
Gender	Male	5 (33)
	Female	10 (67)
Year of Study	4th year	15 (100)
Student perceptions of active learning		
Do you know what "active learning" is?	Yes	12(80)
	Not sure	3 (20)
	No	0
Do the food chemistry modules use active learning methods?	Yes	12 (80)
	Not sure	3 (20)
	No	
How do you describe your overall perception of active learning in the Food Chemistry module?	Effective	12 (80)
	Neutral	3 (20)
	Ineffective	0

Section A of the questionnaire asked about the active learning activities enjoyed by the respondents. Among the respondents, about 19% chose group discussions and problem-solving exercises as the methods they have experienced (Figure 1), while 13% chose peer teaching, case studies and flipped classrooms. 11% of the respondents chose laboratory experiments, while 6% chose simulations and others. As the module coordinators, the researchers used all the active learning methods mentioned in the questionnaire at one time or another. However, the group discussion and solving exercises were more relevant to the food science module since the module is based on solving nutrition problems in real life. The responses from group discussions and problem-solving exercises make me use the two more than the others. Studies have also shown that group discussions and problem-solving exercises help students solve real-life problems more effectively.[49] The other active learning methods were also used to serve a specific purpose during the online or face-to-face classroom. For example, peer teaching is used for students to explain a concept to each other face-to-face, while case studies are used to help solve a similar diet problem. Flipped classrooms are used online to encourage students to engage in discussions. All these methods help the students to understand the module better.

[48] Mokgaetji Georginah Mokganya and Innocent Zitha, "Assessment of First-Year Students' Prior Knowledge as a Pathway to Student Success: A Biology Based Case," in *Proceedings of The Focus Conference (TFC 2022)*, vol. 732 (Paris: Atlantis Press SARL, 2023), 233–46, https://doi.org/10.2991/978-2-38476-006-0_19.

[49] Innocent Zitha, Ditshego Masete, and Sarah Matsetela, "Using Artificial Intelligence Tools for Providing Feedback as A Strategic Response to Addressing Challenges in Students' Academic Writing," *E-Journal of Humanities, Arts and Social Sciences* 6, no. 7 (June 18, 2025): 1096–1111, https://doi.org/10.38159/ehass.20256712.

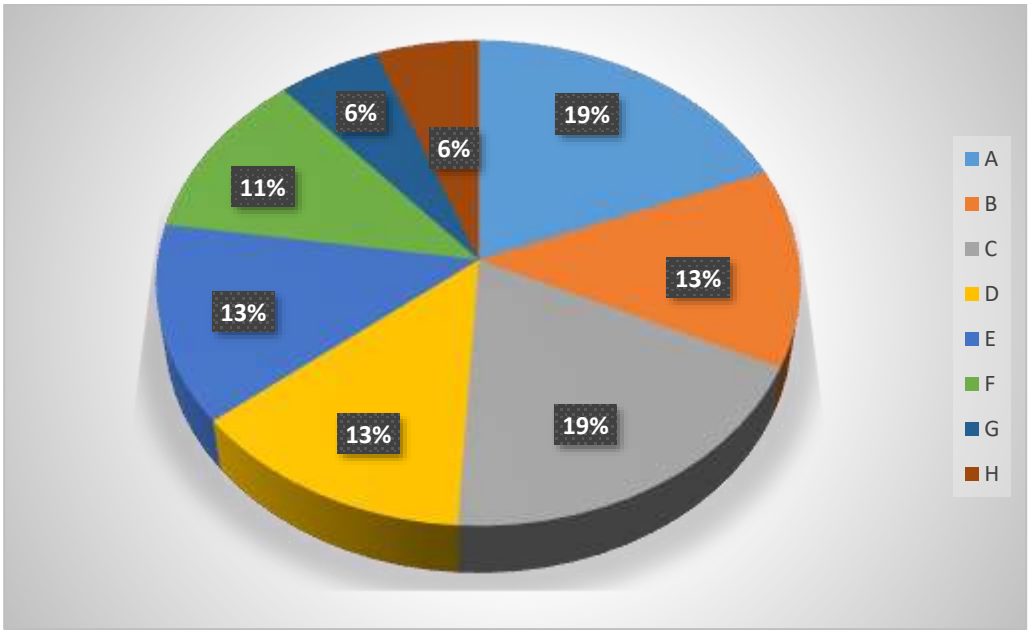

Figure 1. The active learning methods that the respondents have experienced in the Food Chemistry module.

(Keys: A is a Group discussion, B is Peer teaching, C is problem-solving exercises, D is Case studies, E is a flipped classroom, F is Laboratory experiments, G is Clicker quizzes, H is simulations, and I is others).

The responses obtained from the respondents showed the best active learning methods that have a good influence on the students in the module on food chemistry. The methods are to be continued to increase the pass and graduation rates in the Food Science and Technology field. This speaks to the second objective of the study.

Benefits and Challenges of Active Learning

Tables 2A & B show the respondents' responses to the benefits and challenges of active learning in the food chemistry module. Table 2A shows the benefits. 80% of respondents agreed that active learning helps develop critical thinking skills, while 73% agreed that it increases their engagement in the food chemistry module. About 60% of the respondents believe that active learning improves their retention ability, while 47% agreed that it enhances their teamwork skills. These responses align with the report of Allsop et al., who reported the benefits of active learning in higher education.[50] On the other hand, the challenges (Table 2B) faced by the respondents in active learning include unequal participation in group work (80%). Distraction during collaborative tasks (60%) and difficulty managing time (40%). It is expected that there will be a few challenges in the active learning methods, but these challenges can be overcome if learners are ready to follow instructions and speak out for help.

Table 2A: Benefits of Active Learning

Options	Responses	Percentage (%)
Increased Engagement	11	73
Improved retention of material	9	60
Enhanced teamwork skills	7	47
Development of critical thinking	12	80

[50] Jared Allsop et al., "Examining the Benefits Associated with Implementing an Active Learning Classroom among Undergraduate Students.," *International Journal of Teaching and Learning in Higher Education* 32, no. 3 (2020): 418–26.

Table 2B: Challenges of Active Learning

Options	Responses	Percentage (%)
Unequal participation in group work	12	80
Distraction during collaborative tasks	9	60
Difficulty managing time	6	40

The Importance of the Instructor's Role

The respondents were surveyed regarding the significance of the instructor's role within the food chemistry module. The data presented in Figure 2 illustrate the participants' responses. Approximately 81% of the respondents acknowledged that the role of the instructor in facilitating active learning is of considerable importance. In contrast, 13% of the respondents expressed the opinion that the instructor's role is not very important, while 6% indicated uncertainty regarding its significance. This data showed that a more significant percentage of the respondents agreed that instructors played a vital role in the use of active learning, and this agrees with the report of which reported that instructors are key players in the use of active learning in higher education.[51] Also, Ito and Takeuchi. explained that instructors play essential roles in active learning, and instructors are responsible for the effectiveness of active learning.[52]

The 13% of students who consider the classes not very important might be those whose attention is divided during the session, or they may face financial challenges that prevent them from joining the online classes, such as inadequate data, poor-quality phones, or a lack of a laptop. The 6% of students who are not sure about the importance of the class may be those who are repeating the module.

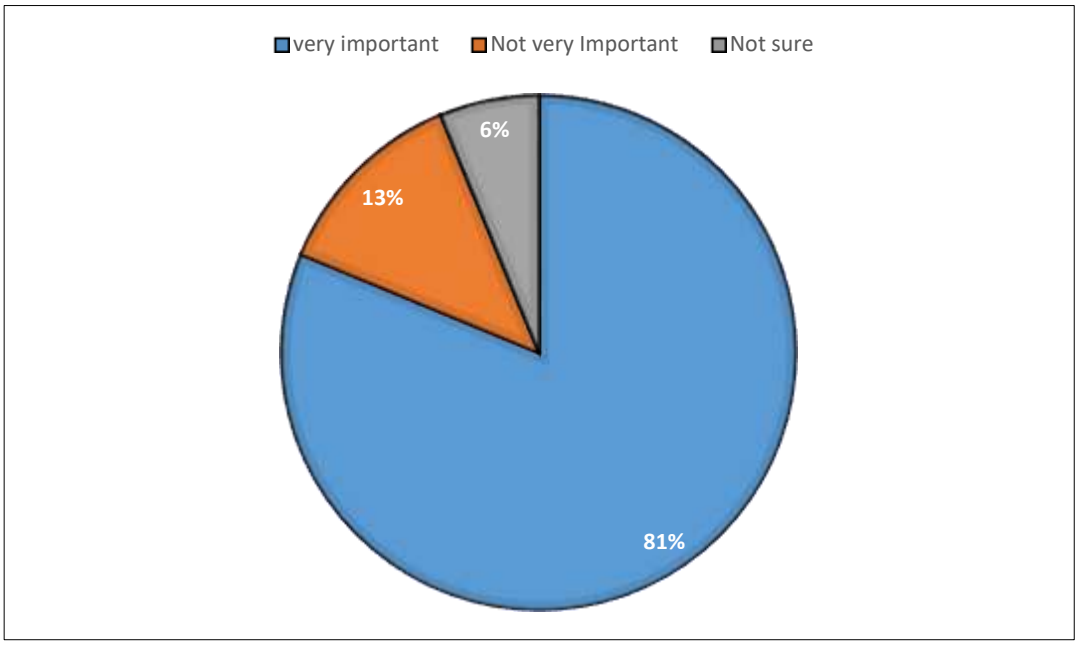

Figure 2: Importance of the Instructor's Role in Active Learning

To gain a comprehensive understanding of the role instructors play in active learning, a question was posed regarding effective instructional strategies within the food chemistry module. Table 3 displays effective instructor's strategies in Active learning among university students. An overwhelming 93% of the participants indicated a preference for clear instructions from their instructors, while 73% expressed the desire for active facilitation during the learning process. Furthermore, 60% of the respondents identified the need for constructive feedback, and 53% requested

[51] Liudmila Mikalayeva, "Motivation, Ownership, and the Role of the Instructor in Active Learning," *International Studies Perspectives* 17, no. 2 (2016): 214–29.

[52] Hiroshi Ito and Shinichi Takeuchi, "The Demise of Active Learning Even before Its Implementation? Instructors' Understandings and Application of This Approach within Japanese Higher Education," *Education Inquiry* 13, no. 2 (2022): 185–204.

more structured guidance on the application of active learning techniques within the food chemistry module. These findings underscore the critical importance of clear instructions in the implementation of active learning in higher education. Students prefer direct and unambiguous instructions to minimise confusion when addressing questions. Additionally, constructive feedback is vital as it assists students in recognising areas that require improvement. These results showed that the strategies employed by instructors show how effective active learning could be in higher education. This finding is similar to the report of Tharayil et al., who reported that the strategies employed by instructors improve the effectiveness of active learning in higher education.[53]

Personal Engagement in Active Learning

The questionnaire assessed the level of participation in active learning among the respondents, as illustrated in Figure 3. Of the total number of respondents, twelve (12), representing 80%, actively participated in the learning process. One respondent (7%) remained neutral, while 13% expressed uncertainty regarding their participation. Active engagement from learners provides instructors with valuable insights into the effectiveness of active learning methods used in the module.

Table 3: Effective Instructor's Strategies in Active Learning

Options	Responses	Percentage (%)
Clear Instruction	14	93
Active facilitation	11	73
Constructive feedback	9	60
Provide more structured guidance	8	53

The positive feedback that the lecturer received may explain the increase in the pass rate for the food chemistry module since the facilitator began teaching it in 2022. Previously, the pass rate ranged from 35% to 50%, which meant that many students did not to graduate due to difficulties in this module. The increase in student participation in active learning has been linked to an improved pass rate, indicating that active learning is one of the most effective teaching methods in higher education.[54]

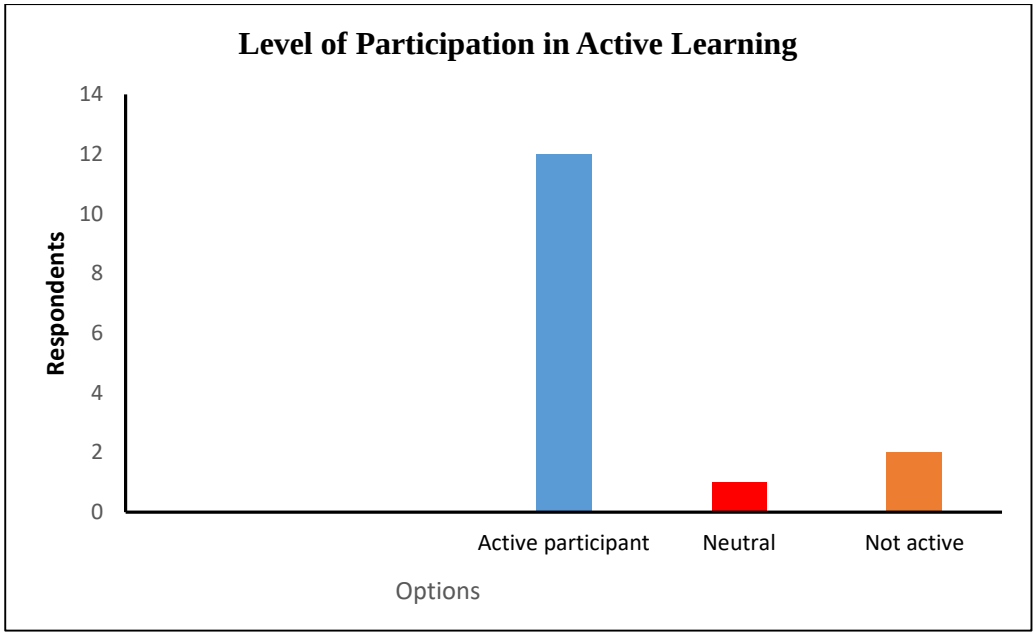

Figure 3: Level of Participation in Active Learning by the Students

[53] Tharayil et al., "Strategies to Mitigate Student Resistance to Active Learning."
[54] Freeman et al., "Active Learning Increases Student Performance in Science, Engineering, and Mathematics."

Part B of the personal engagement in active learning focuses on the factors influencing participation in active learning. Table 4.4 displays the responses gathered from the participants. Eleven participants identified the real-world relevance of activities as a key factor affecting their engagement. Conversely, nine respondents cited a lack of clarity in expectations and issues with group dynamics as factors that discouraged their participation in active learning. Additionally, two respondents mentioned that the enthusiasm of instructors also influences their engagement. Given that the module on Food Chemistry relates to human nutrition, which has real-world implications, the feedback indicates that students are generally very pleased with the active learning approach in this module. However, other factors, like the instructor's enthusiasm, lack of clarity in expectation and issues with group dynamics, may be negative factors due to what the module contains. The module contains the chemistry of foods, which requires daily reading to master the chemical equations and mechanisms. Also, the large number of females in the module, which makes the female students more in a group than males, may be responsible for the negative factors. All these factors contributed to the responses received from the respondents.

Table 4: Factors Influencing Engagement in Active Learning

Options	Responses	Percentage (%)
Real-world relevance of activities	11	73
Instructor enthusiasm	2	13
Lack of clarity in expectations	9	60
Issues with group dynamics	9	60

Improvement and Feedback

The final section of the questionnaire solicited participants' perspectives on areas that require improvement, as well as feedback regarding the active learning methods employed in the Food Chemistry module. The findings are detailed in Table 4.4 and illustrated in Figure 4.4. With respect to the improvement inquiries presented in Table 4, 73% of respondents indicated a desire for greater variety in the active learning activities. Although the researchers believe that a diverse range of activities has been provided, it is apparent that various factors may hinder student participation. Notably, 93% of participants reported a need for better structure and clearer instructions for the activities. This observation raises concerns for me, as the researchers had assumed that the facilitator was providing adequate guidance within the classes. The instructors must enhance this aspect of the instructor's teaching.

Furthermore, 87% of the respondents expressed a preference for smaller group sizes to facilitate equitable participation. Consequently, I will adjust the group size from five students to three. Additionally, respondents articulated a need for increased instructor involvement in facilitating group activities. This feedback is not entirely unexpected, as the researchers have previously encountered complaints from group leaders regarding the lack of participation of some group members during collaborative tasks.

The researchers believe that the responses from the participants accurately reflect the situation in the module, which makes this study effective and will help me develop a better plan for the module in the future. These findings align with those reported by Telore & Damtew, who stated that instructors' participation in active learning reduces the challenges learners face.[55]

Figure 4 shows the participants' responses to the instructor's feedback. About 87% of the respondents believe that feedback to the instructor is very important, 6% said that feedback is not important, and 7% were unsure. Feedback to instructors in active learning is very important because it helps the instructor to adjust to what the learners want.[56] The act of receiving feedback from the

[55] Tesfanesh Telore and Abebe Damtew, "Role Of The Teacher In Active Learning: Efl Teachers'perceptions, Practices And Challenges Of Implementation," *Celtic: A Journal of Culture, English Language Teaching, Literature and Linguistics* 10, no. 2 (2023): 172–93.

[56] Linda Van den Bergh, Anje Ros, and Douwe Beijaard, "Improving Teacher Feedback during Active Learning: Effects of a Professional Development Program," *American Educational Research Journal* 51, no. 4 (2014): 772–809.

students helps me to teach them so that they understand each concept. The data obtained from the students showed the true reflection of how the students saw the changes in this module of the teaching method after feedback.

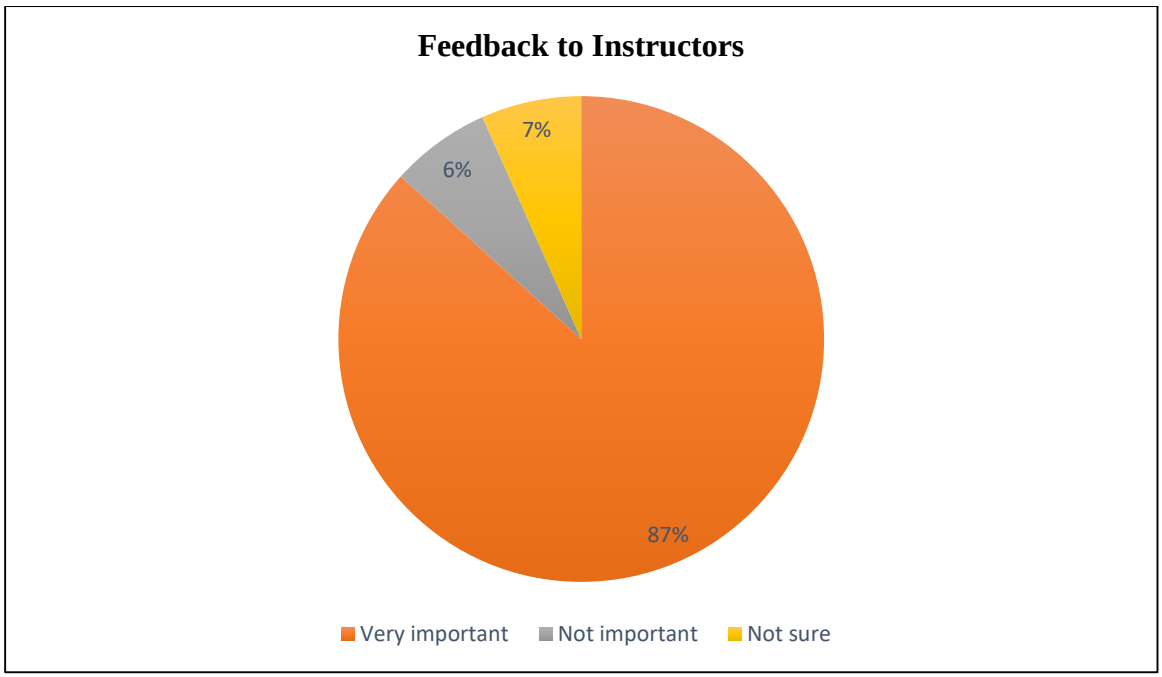

Figure 4: Feedback to Instructors by the students

The Oral Interview Results and Interpretation

The qualitative component of this research study involved interviewing five students about their experiences with active learning in the food chemistry module. The oral interviews were conducted to gather data on the impact of active learning in this specific module. Four students provided positive feedback, while one student expressed a negative perspective. Below is a summary of each question posed to the students, along with an analysis of the key themes that emerged from their responses. Five questions were asked of each student.

1. **What do you understand by active learning, and how do you engage in active learning in the food chemistry module**?

Four positive responses were received. The participant defined active learning as an interactive approach that involves firsthand activities, group discussions, problem-solving tasks, and a flipped classroom. They described participating in lab experiments, collaborating on group projects, and participating in in-class discussions. Most of the students stated that they appreciate the practical aspect of learning, particularly through hands-on experiments, which made complex concepts easier to grasp. Example of a response from a student*:*

> *Active learning, to me, means being actively involved in the learning process rather than just passively listening to lectures. In the Food Chemistry module, I participated in experiments and group discussions, which helped me understand some of the concepts better.*

One of the negative responses received showed that the student understood active learning but felt it was not well integrated into the course. This student reported less engagement in the active learning activities and felt that the course should be both traditional lecture-based and active learning.

Response from the student:

> *Active learning sounds good in theory, but in this module, I did not feel like it was really applied well. We still spent most of the time doing group discussions and assignments rather than listening to the lecturer teach us.*

It is essential to acknowledge that not all students favour active learning; however, a significant 90% of respondents indicated their enjoyment of its application in the food chemistry module. The majority of students demonstrate an understanding of active learning and engage in various strategies associated with it. Nevertheless, a particular student expressed a sense of disconnection from these strategies, highlighting the possibility that the implementation of active learning was not consistently applied throughout the module. This observation suggests that while active learning is regarded as valuable, it may not have effectively reached all students. This conclusion is consistent with the findings presented by Fraser et al, which indicate that not every student appreciates the use of active learning in higher education.[57]

2. **How frequently do you engage in active learning activities in the Food Chemistry module**?
The participants reported frequently engaging in active learning activities such as group discussions, problem-solving tasks, flipped classrooms and hands-on experiments. Most of the participants noted that they participate in at least one active learning activity per class or per week. Group projects and laboratory experiments were highlighted as particularly frequent.
Example of a response from a student*:*

> *We engage in some form of active learning in almost every class. I would say we have discussions or group activities every week, and we often have lab sessions where we apply what we have learned.*

Example of a negative response:

> *I only recall a few sessions where we had hands-on activities. Most of the time, it felt like traditional lectures with little opportunity to apply what we learned.*

This type of response is believed to come from students who only attended a few face-to-face classes and did not attend online classes. Some of them give excuses such as “I am sick,” “no internet connection in my hostel,” and “I do not like peer teaching.” These and many more excuses are given when students engage in discussions. The University of Venda asked lecturers to report such students as “students at risk.” Not all students would love to participate in active learning, and instructors need to find a way to bring all students to the table for effective teaching. This is in line with the report by Ribeiro-Silva et al, who reported students' acceptance of active learning in schools and higher education.[58]

The third oral question asked during the student's oral interview was on a scale from 1 to 5, where 1 indicates “not at all” and 5 indicates "extensively”.

3. **Please rate how much you believe active learning strategies have contributed to your grades in the Food Chemistry module**
All the students rated the contribution of active learning as either a 4 or a 5. They felt that flipped classrooms and laboratory practicals helped reinforce theoretical concepts, positively influencing their grades. Group discussions and problem-solving activities were also mentioned to aid in their understanding of the course material. It could be said that all students perceive a strong correlation between active learning and their academic performance, with a highly rated score. This is in line with the report by Howell, who reported a positive response from students taught using active learning methods.[59]

[57] W J Fraser, M Beyleveld, and J J R De Villiers, “The Use of Active Learning in a Private Higher Education Institution: The Lecturer’s Perspective,” *South African Journal of Higher Education* 33, no. 2 (2019): 16–28.
[58] Elsa Ribeiro-Silva et al., “Trends of Active Learning in Higher Education and Students’ Well-Being: A Literature Review,” *Frontiers in Psychology* 13 (2022): 844236.
[59] Rachel A Howell, “Engaging Students in Education for Sustainable Development: The Benefits of Active Learning, Reflective Practices and Flipped Classroom Pedagogies,” *Journal of Cleaner Production* 325 (2021): 129318.

4. **Do you believe active learning activities have improved your understanding of course material and knowledge retention in Food Chemistry**

All the students answered "yes" and gave different examples and instances. One of the examples of their response is below.

Example of a response from a student*:*

Yes, I remember more when I do the experiments myself rather than just reading about them.

Active learning seems to contribute positively to understanding and retention for most students. This is because the practical classes, the group discussions and problem-solving tasks are related to the test and examination questions. Practical classes are said to help improve a student's knowledge retention capacity.[60] This is encouraging for me because the technicians are working together, which supports my active learning methods.

The last oral question asked participants about the form of active learning methods they found most effective.

5. **Which forms of active learning do you find most effective in enhancing your learning experience in the Food Chemistry module?**

Example of a student response:

Definitely the group discussion and lab experiments. They really help me see the theory in action."

The responses of all participants in this oral interview correlate with the answers that some of the respondents gave in the questionnaires. Although 11% of the respondents chose laboratory experiments, laboratory experiments came out strongly as active learning methods that improved the participants' grades in the Food Chemistry module. The oral interviews provided insightful data on how students perceive and engage with active learning in the Food Chemistry module. The overall feedback provides an understanding of how active learning impacts student engagement, learning, pass and graduation rates. The feedback from the oral interview is similar to the report of Poole, who reported that oral interviews provide insightful data on active learning.[61]

RECOMMENDATIONS

The findings of this study underscore the importance of regularly assessing student performance in each module. It has become clear that a passing grade does not necessarily indicate student satisfaction with the lectures or practical components. In response to this observation, the researchers plan to implement weekly or biweekly assessments in the form of structured discussions and dialogues with my students. This study encourages other lecturers to consider adopting similar practices, as they can provide valuable insights into the effectiveness of active learning methods in improving student engagement and understanding. Additionally, lecturers should conduct one-on-one dialogues with students, which will enable instructors to promptly identify those who may be at risk and to provide appropriate support.

Although this study has produced valuable results, it is important to recognise certain limitations that should be considered. One such limitation is the small sample size, as only fifteen students participated in the study. Furthermore, the findings may have benefited from a longer data collection period; the researchers believe a duration of at least six months is necessary for thorough data interpretation. However, the results presented here accurately reflect the current situation within the module and within the department.

The researchers have received positive feedback regarding the enjoyment students find in attending my classes, as well as the increased pass rate for this module since I began teaching it in 2022.

[60] Afzal Sayed Munna and Md Abul Kalam, "Teaching and Learning Process to Enhance Teaching Effectiveness: A Literature Review," *International Journal of Humanities and Innovation (IJHI)* 4, no. 1 (2021): 1–4.

[61] Karen Poole, "A Flipped Classroom Approach to Teaching Search Techniques for Systematic Reviews to Encourage Active Learning.," *Journal of Information Literacy* 15, no. 1 (2021): 68–83.

The reliability of these findings suggests that they can serve as a valuable resource for further research. The processes involved in data collection and interpretation have been meticulously documented to ensure transparency and reliability. Importantly, the findings were not influenced by the predispositions of the researcher.

To promote ongoing improvement in student outcomes, the researchers recommend that similar research be conducted across all modules within the department. Additionally, it would be beneficial for the university to encourage instructors to adopt active learning methodologies, particularly among those who have not yet done so. This initiative would enhance student learning experiences and contribute to the overall advancement of our educational system.

CONCLUSION

Reflecting on the research conducted in the Food Chemistry module within the Department of Food Science and Technology at the University of Venda, the findings underscore the significant role of active learning strategies in bolstering students' academic performance. The investigation revealed a positive trend in pass and graduation rates among students, attributed to this success and to the incorporation of active learning methodologies. Notably, the demographic composition of the cohort, predominantly female with a smaller representation of male students, demonstrated a generally favourable reception towards both questionnaires and oral interviews conducted as part of the study.

Despite the overall positive outcome, it is crucial to recognise that active learning did not resonate equally with all participants. A segment of the student population, particularly those with previous unsuccessful attempts at the module, expressed reluctance and negative perceptions towards engaging in group discussions, problem-solving tasks, and even participation in online and practical classes. This subset of students, identified as at-risk, highlighted the need for additional support mechanisms, such as psychological services, to address their unique challenges and encourage a more inclusive educational experience.

Through the analysis of student feedback, a direct correlation emerged between the adoption of active learning strategies and enhanced academic achievement in the Food Chemistry module. It is important to say that my teaching philosophy, which is centred around cognitive constructivism, encourages the responses received in this study. Students particularly valued the dynamic nature of group discussions, problem-solving exercises, practical sessions, flipped classrooms, and peer teaching, underscoring their effectiveness in enriching the learning experience. These insights not only affirm the positive impact of active learning on students' success in the Food Chemistry module but also directly address the core research question, offering valuable implications for future pedagogical practices within the Department of Food Science and Technology.

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