Review Article

Addressing Challenges in Engineering Education: A Case Study of Materials Technology Course

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Abstract

Engineering education continually faces the dual challenge of maintaining high student engagement while ensuring academic integrity. This article presents a comprehensive case study of the MEC3203 Materials Technology course at the University of Southern Queensland (UniSQ), Australia. After assuming the role of Course Coordinator in 2018, several significant issues were identified, including low student engagement, frequent breaches of academic integrity and poor student evaluation scores. A series of strategic interventions was implemented in response to these challenges. First, the course materials were extensively updated to reflect the latest advancements in materials technology, aiming to enhance the relevance and applicability of the content. Second, real-world engineering practices were integrated into the curriculum through the incorporation of industry case studies, guest lectures from professionals in the field, and practical assignments designed to simulate real engineering challenges. These changes aimed to provide students with a deeper understanding of the subject matter and its practical application. Furthermore, efforts were made to foster a supportive and interactive learning environment. The outcomes of these interventions were significant. There was a marked increase in student engagement, demonstrated by higher attendance rates and more active participation in class activities. Incidents of academic integrity breaches decreased, indicating a stronger adherence to ethical standards. Moreover, overall course satisfaction improved substantially, as reflected in higher student evaluation scores and feedback.

Introduction

Engineering education is crucial for preparing students to meet the demands of the rapidly evolving technological landscape. Advancements in technology and engineering practices necessitate an education system that can adapt and evolve quickly. This adaptability is essential for students' immediate academic success and their long-term career prospects in a competitive global market. However, educators face significant and multifaceted challenges in achieving this goal. Maintaining student engagement is a primary concern, especially as traditional teaching methods may no longer suffice. Active learning strategies, such as problem-based learning and collaborative projects, can significantly enhance student engagement and retention of material [1,2]. Additionally, ensuring academic integrity has become increasingly complex with the rise of digital tools and resources. Educators are continually developing new methods to uphold academic standards, including plagiarism detection software and fostering a culture of integrity through honour codes and ethical training [3]. Aligning coursework with industry needs is another critical challenge. As industries evolve, the skills and knowledge required from graduates also change. Curricula must be regularly updated to reflect current industry practices and technological advancements, often involving collaboration with industry professionals [4].

This article examines the case of MEC3203 Materials Technology, a course designed to provide undergraduate mechanical engineering students with a comprehensive understanding of material properties, applications, and technological advancements. The course employs various strategies to address the aforementioned challenges, ensuring that students engage with the course materials, uphold academic integrity, and acquire skills directly applicable in the industry. MEC3203 incorporates interactive simulations and real-world case studies to enhance engagement and practical understanding. Regular updates to the curriculum, informed by industry trends and feedback from professional engineers, help align the course with current industry standards. Furthermore, assessments are designed to test both theoretical knowledge and practical skills, providing a holistic approach to evaluating student learning. By examining the strategies employed in MEC3203 and their impact on student outcomes, this article aims to contribute to the broader discourse on effective engineering education practices.

Learning and Teaching Challenges

Before Semester 1, 2018, MEC3203 Materials Technology faced several significant challenges that severely impacted the course's effectiveness and the students' learning experience. One of the most pressing issues was student engagement, evidenced by poor attendance, minimal participation in class discussions, and a general reluctance to engage with the materials outside of mandatory assignments. This disengagement hindered students' ability to absorb and retain the course material and affected the overall classroom dynamic.

Another critical issue was academic integrity. The course was plagued by extensive issues with plagiarism, contract cheating, and other forms of academic dishonesty. Many students resorted to copying assignments, collaborating inappropriately on individual tasks, hiring others to prepare assignment reports, and using unauthorized resources during exams. These practices undermined the integrity of the academic assessment and devalued the learning process.

Additionally, student feedback for the course was predominantly negative, reflected in low student evaluation scores. Feedback highlighted several areas of dissatisfaction, including the perceived irrelevance of the course content, the lack of practical applications, and inadequate support provided by the instructor. This negative feedback indicated that the course was not meeting students' expectations and was failing to provide a satisfactory educational experience.

These challenges necessitated a comprehensive review and overhaul of the course to foster a more engaging, honest, and supportive learning environment that better meets the students' needs and aligns with academic standards.

Initiative and Teaching Practice

Recognizing the need for substantial changes, a multi-faceted approach was adopted to address the challenges faced by the MEC3203 Materials Technology course. The initiative focused on updating course materials, integrating real-world practices, and engaging industry experts to create a more engaging and effective learning environment.

Updating Course Materials

One of the first steps was to overhaul the outdated course content, replacing it with up-to-date, industry-relevant materials. This included the introduction of real-world engineering failure case studies designed to stimulate student curiosity, enhance independent learning, and develop essential research and report-writing skills. These case studies provided students with concrete examples of engineering challenges and failures, prompting them to think critically and apply theoretical concepts to practical problems.

Integrating Real-World Practices

To emphasize the practical application of course content, several strategies were implemented. Real-world case studies were included in the teaching materials and used for analysis and assessment, giving students hands-on experience with practical engineering problems. Additionally, mandatory viva voce sessions were introduced following major assessments. These interviews verified the authenticity of student work, provided a platform for personalized feedback, and allowed instructors to address individual student concerns. Drawing from the literature on oral examinations [5], these viva voce sessions prepared students for real-world engineering scenarios and deepened their understanding of course content.

Engaging Industry Experts

To bridge the gap between academic learning and practical application, industry experts were invited to deliver guest lectures. This initiative provided students with valuable insights into real-world engineering practices and highlighted the practical relevance of their coursework. Guest lectures by professionals from the field increased student motivation and engagement by showcasing how theoretical knowledge is applied in real-world contexts.

By adopting this multi-faceted approach, the course experienced significant improvements in several areas. The updated course materials made learning more engaging and relevant, while the integration of real-world practices ensured that students could apply their knowledge effectively. Engaging with industry experts enhanced student motivation and provided a clear link between academic concepts and their practical applications.

Impact on Students

The implementation of these initiatives yielded significant positive outcomes for the MEC3203 Materials Technology course, significantly enhancing the overall student experience.

Improved Student Engagement

One of the most notable impacts was the marked improvement in student engagement. Feedback from students indicated a heightened interest in the subject matter and a deeper understanding of practical engineering applications. The updated course content and the incorporation of real-world case studies played a crucial role in this improvement. These elements made the material more relevant and interesting, significantly enhancing critical thinking and problem-solving skills [6-12].

Enhanced Academic Integrity

The introduction of mandatory viva voce sessions was another impactful change. These sessions ensured the originality of student submissions by providing a robust mechanism for verifying the authenticity of their work. More importantly, the viva voce sessions offered valuable opportunities for one-on-one interaction between students and instructors, fostering a supportive and responsive learning environment.

Positive Course Evaluations

Course evaluations reflected the positive changes, showing a consistent increase in student satisfaction. Students praised the updated and relevant content, the interactive elements of the course, and the guest lectures. These guest lectures, delivered by industry professionals, were highlighted as particularly beneficial, as they demonstrated the relationship between theoretical knowledge and its practical application in the industry.

Unsolicited testimonials from students underscored the positive impact of these changes. Students emphasized the value of personalized feedback during viva voce sessions and appreciated the integration of real-world problems into the curriculum. These testimonials highlighted how the course's new structure and content had significantly enhanced their learning experience, making it more relevant, engaging, and practical.

Table 1 summarizes the positive outcomes achieved from the interventions and objectives set in the MEC3203 Materials Technology course.

Intervention	Objective	Outcome
Update Course Materials	Enhance relevance and applicability	Increased student interest and understanding
Integrate Real-World Practices	Provide practical experience	Improved critical thinking and problem-solving skills
Engage Industry Experts	Bridge gap between theory and practice	Higher student motivation and engagement
Implement Viva Voce Sessions	Ensure academic integrity and personalized feedback	Decreased incidents of academic dishonesty and supportive learning environment

Table 1: Achieved outcomes from set interventions and objectives.

Sustaining the Initiative

To ensure the sustainability of the innovative teaching practices and their continued positive impact, several measures have been institutionalized within the MEC3203 Materials Technology course at UniSQ.

Institutionalizing Updated Course Content

Regular engagement with industry professionals through the Discipline Industry Advisory Committee (IAC) and other channels ensures that the course materials remain up-to-date and aligned with current engineering practices. The IAC, composed of experienced industry practitioners and academic experts, provides valuable insights into the latest trends and requirements in the engineering field.

Maintaining Mandatory Interviews

The viva voce process, which has proven effective in enhancing academic integrity and providing personalized feedback, has been embedded into the course framework as a permanent feature. This consistent implementation ensures that each cohort of students benefits from this interactive and evaluative process.

Continuous Feedback Loop

A continuous feedback loop with students has been established to ensure the course remains dynamic and responsive to their needs. Regular surveys, informal discussions, and feedback sessions gather student opinions and suggestions. This proactive approach ensures that the course adapts to the evolving expectations and learning preferences of students.

Training and Mentorship

Regular training sessions and mentorship programs for casual academics and course team members ensure consistent and high-quality delivery of the course content. These sessions equip educators with the latest pedagogical techniques and industry knowledge, enabling them to effectively convey complex engineering concepts.

By institutionalizing these measures, the course has established a robust framework for sustaining its innovative teaching practices. Regular industry engagement, the embedding of the viva voce process, a continuous feedback loop, and comprehensive training and mentorship for educators ensure that the course remains relevant, effective, and responsive to the needs of students and the engineering profession.

Contribution to Learning and Teaching Goals

The initiatives implemented in the MEC3203 Materials Technology course align with and contribute to the University's overarching learning and teaching priorities. One of the primary goals is to promote active learning and uphold academic integrity, both of which have been successfully addressed through the strategic interventions in this course. The incorporation of real-world engineering failure case studies and the integration of practical applications into the curriculum have transformed the learning experience from passive reception to active engagement. Moreover, the mandatory viva voce sessions have fortified academic integrity by ensuring the authenticity of student work and fostering a culture of honesty and ethical behavior.

Another significant contribution is the enhancement of industry engagement and the development of employability skills. By regularly involving industry professionals through guest lectures and advisory committee inputs, the course provides students with direct exposure to current industry practices and trends. This not only enriches the learning experience but also equips students with the skills and knowledge that are highly valued in the job market.

These initiatives have also contributed to higher student satisfaction and retention rates. Regular updating of course materials, inclusion of interactive elements, and consistent provision of personalized feedback have enhanced student satisfaction.

Conclusion

The transformation of the MEC3203 Materials Technology course exemplifies a comprehensive approach to addressing the multifaceted challenges in engineering education. By updating course materials, integrating real-world practices, and engaging industry experts, the course has significantly improved student engagement, academic integrity, and overall satisfaction. The incorporation of interactive simulations, real-world case studies, and mandatory viva voce sessions has made learning more relevant and dynamic, while fostering a culture of honesty and ethical behavior. Sustaining these innovative teaching practices through institutionalized measures ensures that the course remains aligned with industry standards and responsive to students' evolving needs. The success of these initiatives underscores their potential to enhance engineering education broadly, preparing students for successful careers in a competitive global market.

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