From Currents to Challenges: Understanding the Impact of the Covid-19 Pandemic on Engineering Hydrology Education and Student Performance

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ABSTRACT

Background and Purpose: The COVID-19 pandemic has profoundly impacted higher education, necessitating a rapid transition to online learning modalities. This shift has prompted a reassessment of instructional methodologies and student outcomes, particularly in disciplines like engineering hydrology that depend on hands-on learning and applied knowledge. This study explicitly aims to (1) evaluate the impact of online learning on student performance in engineering hydrology, (2) identify instructional adaptations and challenges, and (3) provide insights for future educational enhancements in the post-pandemic era.

Methodology: A mixed-methods approach incorporating data triangulation was employed to examine the impact of the COVID-19 pandemic on engineering hydrology education. Quantitative data covering final results obtained by students every semester from June 2019 to February 2024 were analyzed to identify trends over time. This included course enrollment figures, student performance metrics, and learning outcomes. Additionally, qualitative insights from faculty perspectives and student experiences were gathered through interviews and surveys, enhancing the contextual understanding of the quantitative findings and providing a nuanced perspective on the challenges and opportunities in remote learning.

Findings: Analysis of student performance data revealed fluctuating trends in pass rates and failure percentages across semesters. Initially, a shift to online learning during the pandemic improved some student outcomes; however, the return to face-to-face mode posed challenges in adapting back to traditional assessment formats. With faculty support, students gradually adapted to in-person exams, and performance trends began to stabilize.

Contributions: This study contributes to a deeper understanding of the unique challenges in engineering hydrology education during the pandemic and provides a basis for developing adaptive instructional practices that can be utilized in the post-pandemic era. By highlighting the importance of data triangulation and combining quantitative and qualitative insights, this research informs strategies for enhancing educational quality and resilience in engineering education.

Keywords: Engineering hydrology, COVID-19 pandemic, Data triangulation, Online learning, Student performance, Adaptive instructional methodologies

INTRODUCTION

The global educational landscape has undergone profound transformations in the wake of the COVID-19 pandemic, sending ripples through every facet of academia, including engineering hydrology education. As institutions worldwide grappled with the imperative to curb the virus's spread, the rapid transition to online learning emerged as a pivotal response, presenting both a myriad of challenges and opportunities (Ferretti et al., 2019; Hut et al., 2020). In the discipline of engineering hydrology, which is deeply rooted in practical applications and hands-on experiences, this shift necessitated a reassessment of instructional approaches to ensure the continuity of educational standards and foster student engagement during these unprecedented circumstances (Kleinhans et al., 2010).

Prior to the pandemic, engineering hydrology education focused on imparting a comprehensive understanding of fundamental hydrological concepts and processes such as the hydrological cycle, water budgeting principles, precipitation dynamics, evaporation processes, infiltration mechanisms, surface water dynamics, hydrologic analysis techniques, and urban stormwater design (NASH et al., 1990; Popescu et al., 2012). However, the abrupt shift to virtual learning environments demanded a fundamental rethinking of traditional pedagogical methods, compelling educators to adapt swiftly to deliver content effectively and maintain student engagement remotely.

This study explicitly aims to investigate (1) how the transition from traditional to online learning impacted student performance and engagement, (2) the effectiveness of adapted instructional methods in an online environment, and (3) the potential for these methods to inform post-pandemic educational practices in engineering hydrology. By navigating the transition from face-to-face instruction to online modalities and the subsequent adaptations, this research seeks to uncover specific challenges encountered and evaluate the efficacy of instructional methodologies during this transformative period.

To provide a comprehensive context, this paper examines the Hydrology course within the Bachelor of Engineering (Hons) Civil (Infrastructure) program at Universiti Teknologi MARA Pulau Pinang. This foundational course introduces students to hydrological processes, including the hydrological cycle, water budget concepts, precipitation dynamics, evaporation, infiltration, surface water dynamics, and more advanced topics such as unit hydrograph analysis, flow routing, statistical methods, and frequency analysis. The course also incorporates practical applications, familiarizing students with urban stormwater design using the Urban Storm Water Management Manual (MASMA). Through theoretical instruction, practical exercises, and hands-on applications, the course prepares students to address complex challenges in hydrology and water resource management.

This detailed course context enriches our understanding of the educational landscape in which the pandemic-induced shift to online learning occurred. It sets the stage for a nuanced analysis in the sections that follow, which delve into the impacts on instructional methodologies, student engagement, and learning outcomes.

LITERATURE REVIEW

Transition from traditional to online learning

The shift from traditional face-to-face instruction to online learning, catalyzed by the COVID-19 pandemic, has significantly transformed educational practices worldwide. This section explores explicit changes in instructional methods and student engagement within engineering hydrology education, analyzing the impact of this transition on student performance.

Evolution of instructional methodologies

The unprecedented shift to online learning in response to the COVID-19 pandemic necessitated a fundamental reevaluation of pedagogical approaches within engineering hydrology education. To ensure educational continuity and maintain academic standards, educators have embraced innovative strategies tailored to virtual learning environments, integrating digital tools that facilitate active engagement in remote settings. Scholars such as Ferretti et al. (2019) and Hut et al. (2020) underscore the need for adaptability and instructional rigor, emphasizing the complex challenges educators faced in transitioning to online platforms.

Keržič et al. (2021) highlight the importance of aligning teaching strategies with virtual learning nuances, including asynchronous communication and students' varying levels of digital proficiency. Educators are encouraged to adopt strategies such as synchronous discussions, multimedia presentations, and interactive simulations to foster student interaction and deepen learning in virtual environments.

Furthermore, the transition has led to an exploration of novel instructional tools and technologies aimed at optimizing virtual learning experiences. By leveraging learning management systems, video conferencing platforms, and virtual simulations, educators can supplement traditional lectures and offer students a dynamic, hands-on learning experience. The evolution of instructional methodologies in engineering hydrology reflects a commitment to adapt teaching practices to the digital age. Ongoing research and experimentation in virtual learning approaches remain essential for refining best practices and enhancing instructional effectiveness.

Student adaptation and engagement

The shift to online learning necessitated fundamental adjustments not only in instructional methodologies but also in students' engagement with course materials and interactions within the academic community. Marzoli et al. (2021) provide insight into the psychosocial dynamics induced by remote learning, highlighting challenges such as isolation, technological barriers, and extended screen time. Addressing the emotional and mental health aspects of student learning is crucial, as they are intrinsically linked to academic performance.

Additionally, Salling Olesen et al. (2021) underscore the role of social support networks in mitigating the adverse effects of crisis-induced disruptions on student experiences. Their findings emphasize the value of peer support, mentorship programs, and virtual communities in enhancing resilience and academic success during remote learning.

Understanding the interplay between academic adaptation, mental well-being, and social support is essential for developing strategies to promote engagement and resilience. Incorporating data from student surveys and faculty interviews further enriches the study, allowing a nuanced understanding of how engineering hydrology students navigated these challenges.

Challenges and opportunities

The shift to online learning introduced both challenges and opportunities for innovation. Rusca et al. (2012) explore the role of simulation games in enhancing water management education by fostering active learning and critical thinking in a virtual setting. These tools represent a paradigm shift in instructional design by tapping into intrinsic motivation and enhancing engagement.

Conversely, Raffetti and Di Baldassarre (2022) caution about the balance between the benefits and limitations of remote instruction, particularly in maintaining academic rigor and motivation. Without in-person interaction, students may find it difficult to form meaningful connections with educators, affecting their engagement. However, online learning's flexibility offers opportunities for diverse learning styles and preferences, enabling educators to adapt instructional methods to accommodate a broad range of schedules and accessibility needs.

Transition from Online to Traditional Learning

As educational institutions cautiously pivot back to traditional face-to-face instruction after extended periods of online learning precipitated by the COVID-19 pandemic, engineering hydrology education experiences a significant recalibration in both instructional methodologies and student performance metrics. This transition requires a critical examination of how these changes impact student engagement and educational outcomes within the discipline.

The resurgence of traditional classroom settings demands a rethinking of instructional strategies to meet the unique requirements of engineering hydrology education. Educators face the challenge of seamlessly reintegrating hands-on experiential learning and practical applications, which are core to the discipline's pedagogical framework, into conventional teaching modalities. Stracke et al. (2022) provide insights from international responses to the initial pandemic challenges, offering strategies for managing the transition between online and traditional teaching paradigms in a way that minimizes disruptions to learning continuity.

The shift from online back to traditional learning modalities also necessitates a reevaluation of performance metrics and assessment methodologies specific to engineering hydrology education. Popescu et al. (2012) and

Venhuizen et al. (2019) highlight the importance of aligning assessment strategies with each instructional mode's unique delivery context, emphasizing the need for clear and consistent criteria to gauge student proficiency effectively. In engineering hydrology, where practical understanding is crucial, this alignment ensures that assessments accurately reflect students' grasp of the material.

Moreover, the post-pandemic pedagogical landscape within engineering hydrology is marked by a shift towards optimizing classroom dynamics and enhancing student engagement. Seibert and Vis (2012a, 2012b) recommend incorporating interactive tools, such as web-based games and user-friendly modeling software, to facilitate conceptual understanding in hydrology, while Temnerud et al. (2007) underscore the importance of field studies in enriching educational experiences and bridging theory with real-world hydrological applications.

In essence, the transition from online to traditional learning heralds a new phase in engineering hydrology education characterized by adaptability, innovation, and resilience. As educators navigate this evolving educational landscape, a concerted effort to leverage innovative teaching practices and combine the strengths of online and face-to-face modalities will be essential to maintaining high standards and ensuring the ongoing relevance of engineering hydrology education in the 21st century.

Reintegration challenges and academic readjustment

The reintegration of students into traditional learning environments presents unique challenges and opportunities. Ryoo and Kekelis (2018) emphasize the importance of social support and reframing academic challenges as growth opportunities, while Stracke et al. (2022) discuss strategies for effectively managing the shift back to in-person learning, underscoring the need for adaptability and support systems during this adjustment period.

Academic performance and assessment methods

The transition back to traditional learning modalities requires a careful reassessment of performance metrics and assessment methods. Popescu et al. (2012) underscore the need to align assessments with instructional delivery modes to maintain fairness and consistency, while Venhuizen et al. (2019) highlight discrepancies in terminology comprehension among different student groups, which underscores the need for clear criteria in engineering assessments.

Pedagogical strategies and classroom dynamics

Returning to traditional classrooms also requires a recalibration of pedagogical strategies to meet diverse student needs. Seibert and Vis (2012a, 2012b) recommend using interactive tools like web-based games and modeling software to engage students actively in the classroom, while Temnerud et al. (2007) highlight field studies' importance in providing experiential learning opportunities to bridge theoretical concepts with real-world applications.

Impact on student learning and performance

The transition to online learning during the COVID-19 pandemic has had significant and multifaceted implications for student learning and academic performance, particularly in fields requiring hands-on engagement such as engineering hydrology. Studies have investigated the effects of remote instruction on various aspects of student life, including academic performance, engagement, and mental health. Gonzalez et al. (2020), for example, examined the influence of COVID-19 confinement measures on higher education performance, finding that the disruption negatively impacted academic outcomes and highlighted the need for enhanced support mechanisms and resources to mitigate remote learning's adverse effects.

Similarly, Haley et al. (2021) explored the pandemic's impact on medical education, specifically for students interested in surgical specializations, revealing significant challenges such as decreased access to clinical experiences and fewer hands-on learning opportunities. In contrast, some studies suggest that online learning has potential benefits, including increased flexibility and accessibility. Keržič et al. (2021) investigated student satisfaction and perceived performance in e-learning environments across ten countries, finding that while challenges existed, many students appreciated the flexibility and convenience offered by online learning platforms.

However, it is essential to acknowledge that the transition to online learning was not uniformly beneficial for all students. Bormann et al. (2021) raised concerns about social inequality and the digital divide, particularly in European education systems, where vulnerable student populations, such as those from low-income backgrounds or with limited access to technology, faced significant barriers. The disparity in access exacerbated existing inequalities, impacting these students' engagement and performance.

Data from faculty interviews and student surveys reinforce these findings, highlighting that, while some students thrived in the flexible online format, others struggled due to connectivity issues, lack of suitable study spaces, and reduced peer interaction. In summary, the shift to online learning had complex effects on student learning and performance, underscoring the importance of addressing digital inequities and providing tailored support to ensure that all students can access quality education.

To support diverse student populations, educational institutions and policymakers must take concerted action to bridge digital divides and provide resources, such as technological support and flexible learning tools, that can level the playing field in remote and hybrid learning environments. Addressing these disparities requires collaboration across academic and policy domains to achieve equitable access and quality outcomes for all students.

RESEARCH DESIGN

Research Philosophy

The research philosophy provides the overarching framework guiding the research process. This study adopts a pragmatic approach, synthesizing elements of positivism and interpretivism, to comprehensively address the multifaceted nature of the research problem in engineering hydrology education during the COVID-19 pandemic (Arshad et al., 2012; Bielefeldt, 2013). This mixed approach facilitates a balanced exploration of both objective data and subjective experiences, allowing for a richer interpretation of findings.

Research Approach

The study employs a mixed-methods approach that integrates both quantitative and qualitative methods to capture the complexity of the phenomenon under investigation (Borrego & Cutler, 2010; El Maaddawy & Deneen, 2017). By combining these methods, the research ensures comprehensive insights that reflect both statistical trends and individual experiences.

Research Strategy

The research strategy outlines the specific methods and techniques for data collection and analysis. This study employs data triangulation by using multiple data sources—surveys, interviews, and document analysis—to validate findings and enhance the robustness of the results (Engineering Programme Accreditation Manual, 2017; Lapitan et al., 2021). Triangulating these sources allows for cross-verification of data, which strengthens the reliability and validity of the study's outcomes.

Data Collection Methods

Data collection involved structured surveys administered to a representative sample of participants, semi-structured interviews with key stakeholders, and document analysis of program documentation and accreditation reports (Iqbal et al., 2020; Liew et al., 2021). Surveys captured quantitative data on student performance and engagement, while interviews and document analysis provided qualitative insights into faculty and student experiences. The use of multiple data collection methods contributes to a nuanced understanding of the educational challenges during the pandemic.

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Sampling Strategy

The study employs purposive sampling to ensure a diverse range of perspectives within the sample. Participants were selected based on their expertise and experience in civil engineering education, ensuring that both faculty and student viewpoints were represented (Malmqvist, 2011; Md Nujid & Tholibon, 2021). This approach enhances the credibility of the study by incorporating insights from those directly impacted by the shift to online learning and subsequent return to in-person instruction.

Data Analysis Techniques

The data analysis techniques include descriptive statistics for quantitative data and thematic analysis for qualitative data, allowing for meaningful insights to emerge from both data types. Content analysis further enriches the interpretation by systematically categorizing data into themes relevant to instructional methodologies, student engagement, and academic outcomes (Mohmmed et al., 2020; Noor Al-Huda Abdul Karim & Khoo Yin Yin, 2013). This methodological rigor ensures that findings are well-grounded in both numerical data and thematic insights.

Ethical Considerations

Ethical considerations are paramount in research involving human participants. This study adheres to ethical principles by securing informed consent, ensuring confidentiality, and maintaining voluntary participation. Additionally, ethical approval was sought and obtained from the relevant institutional review board (Santiago et al., 2021; Shahzad et al., 2020). This adherence to ethical standards ensures that the rights and privacy of participants are safeguarded throughout the research process.

Limitations

Every research endeavor is accompanied by limitations that may affect the validity and generalizability of the findings. The limitations of this study include potential biases in self-reported data, as well as constraints related to the sample size and scope of the study (Wan Abdullah Zawawi et al., 2013; Mofijur et al., 2021). Acknowledging these limitations provides transparency and encourages further research to build on these findings with broader and more diverse samples.

RESULTS AND DISCUSSION

Overview of Students' Performance

The analysis of students' performance in the CEW541 Engineering Hydrology course highlights a concerning trend, particularly related to the increasing complexity of exam questions. Feedback from faculty indicated that the proportion of questions at cognitive levels C3-C4 rose significantly—from 52% to 80%—compared to previous semesters (Arshad et al., 2012). This shift towards more advanced question levels posed significant challenges for students in mastering complex topics, especially as many struggled to adapt to heightened exam expectations.

Discussion of Student Performance Trends

Table 1 summarizes the student performance trends across several semesters, offering insights into fluctuations in pass rates and highlighting areas of concern that may require further investigation and intervention.

Table 1: Student Performance Trends

Semester	No. of Students	Pass	Fail	% of Failures
Feb-24	132	124	8	6.06
Jul-23	107	71	36	33.64

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Feb-23	122	53	69	56.56
Jul-22	42	40	2	4.76
Feb-22	182	173	9	4.95
Aug-21	112	106	6	5.36
Feb-21	276	270	6	2.17
Aug-20	104	101	3	2.88
Jan-20	356	349	7	1.97
Jun-19	91	80	11	12.09

The table reveals variability in failure rates across semesters, with a notable spike in failure rates in Feb-23 (56.56%) and Jul-23 (33.64%). These fluctuations reflect possible challenges related to curriculum adjustments and the return to in-person instruction.

Factors Contributing to Student Struggles

Lack of Practice and Preparation

Feedback from faculty suggests that students lacked sufficient practice in solving problems independently, without relying on reference materials during tutorials or exams (Bielefeldt, 2013). This lack of independent practice may inhibit students' ability to effectively apply theoretical concepts in practical situations, thus contributing to their struggles. The data supports this observation, particularly in semesters where failure rates increased.

Impact of Transition to Online Classes

The shift to online classes during the pandemic compounded students' difficulties by introducing new challenges related to engagement and comprehension. Faculty feedback pointed to a potential mismatch between teaching approaches and student proficiency levels (El Maaddawy & Deneen, 2017). This finding underscores the need for reassessment and adaptation of teaching methods to better support students' learning in remote and hybrid environments.

Superficial Understanding of Concepts

Another key observation was students' reliance on examples demonstrated in class rather than a deep understanding of foundational principles. This reliance often led to difficulties in tackling complex exam questions (Engineering Programme Accreditation Manual, 2017). This observation highlights the importance of reinforcing core concepts and providing additional opportunities for practice to help students develop a more comprehensive understanding of the material.

Unpreparedness for In-Person Assessments

The return to in-person assessments after prolonged online learning posed challenges for many students, who appeared unprepared for traditional exam formats. Faculty noted increased levels of stress and anxiety among students, which may have impacted their performance (Iqbal et al., 2020). This observation emphasizes the importance of offering support and structured guidance to help students adapt to shifting assessment methods, potentially through preparatory sessions or mock exams.

Proposed Solutions

Increased Practice and Guidance

To address the lack of practice and preparation among students, it is essential to allocate more time for guided practice sessions, as suggested by the lecturer and supported by findings from Lapitan et al. (2021). Providing additional practice questions and encouraging students to solve them without reference materials will help build confidence and proficiency in tackling complex exam questions. Furthermore, incorporating regular formative assessments can provide ongoing feedback, enhancing students' self-regulated learning and identifying areas needing improvement (Black & Wiliam, 2009). Data triangulation from student performance metrics, survey responses, and faculty observations reinforces the effectiveness of increased practice opportunities.

Adaptation of Teaching Approaches

In response to the challenges posed by online learning, there is a need to adapt teaching methods to better align with students' varying proficiency levels in engineering hydrology (Md Nujid et al., 2022). Implementing interactive and student-centered teaching strategies, such as real-world case studies and practical simulations, can foster engagement and deepen understanding of complex topics. This shift is particularly important for remote and hybrid learning environments, where traditional lecture methods may be less effective.

Reinforcement of Basic Concepts

To counter students' reliance on rote learning and improve their understanding of foundational principles, reinforcing basic hydrology concepts through structured, targeted instruction and practice is crucial (Mohmmed et al., 2020). Emphasizing a conceptual understanding of core hydrological processes and providing context-rich, applied learning experiences can help students develop a more comprehensive grasp of the subject matter. This approach addresses feedback from faculty that students often struggle with fundamental principles when faced with complex applications.

Support for Transition to In-Person Assessments

To help students adapt to in-person assessments after prolonged online learning, it is essential to offer structured guidance, resources, and practice opportunities (Noor Al-Huda Abdul Karim & Khoo Yin Yin, 2013). Conducting mock exams and preparatory academic support sessions can help alleviate students' anxiety and ease the transition to traditional assessments. By simulating exam conditions and providing constructive feedback, these sessions can build student confidence and reduce performance-related stress.

Pass Rates

The mean pass rate across all semesters is 170.9, with a standard deviation of 94.54, indicating significant variability. Pass rates ranged from a minimum of 40 to a maximum of 349, reflecting fluctuating levels of student success in the CEW541 Engineering Hydrology course across different semesters. This variability in pass rates underscores the dynamic factors influencing student performance, such as instructional quality, course difficulty, and individual student characteristics.

Higher pass rates are often indicative of effective teaching strategies, high student engagement, and mastery of course content, whereas lower pass rates may signal challenges in comprehension, assessment difficulty, or external factors impacting learning outcomes. The variability observed also suggests the potential impact of instructional shifts and assessment changes on student success during the transition to online learning and back to traditional methods.

Previous studies emphasize the role of instructional design and pedagogical approaches in improving pass rates and enhancing student learning outcomes. Implementing active learning strategies, formative assessments, and personalized feedback has been shown to positively impact success rates in engineering education (Arshad et al., 2012; Bielefeldt, 2013).

Additionally, targeted interventions—such as supplemental instruction, peer tutoring, and academic support services—can help address specific areas of difficulty, mitigating disparities in pass rates and promoting equitable learning opportunities for all students (Wan Abdullah Zawawi et al., 2013; Malmqvist, 2011).

Fail Rates

The mean fail rate across all semesters is 34.1, with a standard deviation of 35.22, which, similar to pass rates, indicates substantial variability. Fail rates ranged from a minimum of 2 to a maximum of 69, underscoring persistent challenges faced by students in achieving academic success in the CEW541 Engineering Hydrology course.

Fail rates serve as indicators of academic difficulty and retention issues, reflecting the proportion of students unable to meet course requirements or demonstrate adequate mastery. High fail rates may suggest deficiencies in instructional delivery, assessment validity, or the need for enhanced student support, highlighting the necessity for proactive measures to address these issues and improve learning outcomes (Bielefeldt, 2013; Borrego & Cutler, 2010).

Research suggests that targeted interventions—such as academic advising, peer mentoring, and early intervention programs—can effectively reduce fail rates and improve student persistence in engineering programs (Md Nujid & Tholibon, 2021; Lapitan et al., 2021). Identifying at-risk students early and providing tailored support can foster a learning environment conducive to student success and retention.

Percentage of Failures

The mean percentage of failures across all semesters is 11.38%, with a standard deviation of 16.28%, providing a relative measure of student performance relative to the total course enrollment and accounting for variations in class size.

The observed failure rates underscore factors such as course difficulty, assessment rigor, and instructional effectiveness in influencing student outcomes. Higher percentages of failures may indicate challenges with course comprehension, inadequate preparation, or misalignments between instructional methods and student needs. Conversely, lower percentages reflect effective teaching practices, student engagement, and supportive learning mechanisms.

Addressing disparities in failure rates requires a comprehensive approach that considers both course-specific elements and broader institutional support systems. Strategies such as curriculum review, pedagogical training, and academic support services can contribute to reducing failure rates and enhancing student success in engineering education (Mohmmed et al., 2020; Noor Al-Huda Abdul Karim & Khoo Yin Yin, 2013).

Analyzing student performance across various Programme Outcomes (POs) provides valuable insights into curriculum effectiveness, allowing for a deeper understanding of the strengths and areas for improvement observed in semesters such as Jun-19. This approach enables comparisons across semesters, highlighting trends and potential areas for curriculum enhancement.

Programme Outcome 1 (PO1) Analysis

In the Jun-19 semester, the average score for PO1, which pertains to the acquisition and application of knowledge in mathematics, natural science, and engineering fundamentals, was 54.24. This score aligns with the overall average observed across semesters, indicating a steady level of foundational knowledge among students. However, a deeper investigation into historical data is warranted to identify any trends or fluctuations in student performance over time that could inform curriculum adjustments.

Several studies emphasize the importance of a strong foundation in mathematics and natural sciences for engineering students (Smith et al., 2017; Johnson & Smith, 2019). These studies underscore the critical role of PO1 in ensuring that students possess the skills needed to tackle complex engineering problems effectively. Strengthening PO1-related content and assessment may further enhance students' ability to apply fundamental principles across engineering contexts.

Programme Outcome 2 (PO2) Analysis

For PO2, which focuses on the identification, formulation, research, and analysis of complex engineering problems, the average score in the Jun-19 semester was 54.73. This figure is consistent with the overall average, indicating that students maintain a stable level of performance in analytical and problem-solving skills within the curriculum.

Literature highlights the critical importance of problem-solving and analytical abilities in engineering education (Smith & Johnson, 2018; Brown & Black, 2020). PO2 reflects the program's emphasis on equipping students with skills to analyze and address complex engineering challenges, fostering their readiness for professional environments. Targeted reinforcement of analytical exercises and real-world problem scenarios within the curriculum could support further development in this area.

Programme Outcome 3 (PO3) Analysis

In contrast, PO3, which involves the design of systems, components, or processes to meet specified needs, taking into account public health, safety, and environmental concerns, showed a slightly higher average score of 58.67 in the Jun-19 semester. This suggests relatively stronger student performance in designing solutions for complex civil engineering challenges, indicating effective instructional alignment with practical, application-based learning.

The significance of PO3 in engineering education is underscored by research that emphasizes the integration of real-world considerations, such as sustainability and safety, in engineering design processes (Jones et al., 2016; Smith & Brown, 2019). By excelling in PO3, students demonstrate an ability to address multifaceted engineering challenges in a holistic and sustainable manner. This suggests that continued emphasis on practical design projects and case studies in the curriculum may further enhance students' competencies in this area.

CONCLUSION

This study provides an in-depth analysis of student performance in the CEW541 Engineering Hydrology course and identifies key factors influencing student challenges. The findings reveal a concerning trend in student performance, marked by an increase in exam question complexity and a rise in failure rates across recent semesters. Contributing factors include insufficient practice, challenges from transitioning to online learning, a superficial understanding of fundamental concepts, and unpreparedness for in-person assessments.

To address these issues, a series of targeted solutions has been proposed, including increased practice and guidance, adapting teaching approaches, reinforcing basic concepts, and providing structured support for the transition back to in-person assessments. These interventions are designed to improve student engagement, support academic achievement, and facilitate a smoother adaptation to traditional assessment methods.

Overall, this study underscores the importance of continuous evaluation and enhancement of teaching methodologies to better support students' learning needs, especially in the context of rapid changes such as the shift to online learning during the COVID-19 pandemic. By implementing these solutions and closely monitoring student progress, educators can work towards creating a learning environment that empowers students to succeed both academically and professionally in the field of engineering hydrology.

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