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PAPER

Creating a Supportive and Effective Learning Environment for Engineering Students: Pedagogical Strategies, Engagement, and Enhanced Outcomes

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ABSTRACT

Engineering education requires a strong emphasis on problem-solving, critical thinking, and practical application of knowledge. To achieve the highest quality of teaching, educators must create a trusting environment that allows students to feel comfortable asking questions and performing to the best of their abilities. This paper outlines the teaching philosophy and practices of an engineering lecturer who has adapted his pedagogical approach across several universities in Sweden and abroad. The author emphasizes the importance of being flexible and responsive to student needs, offering early and constructive feedback, and providing students a safe and supportive learning environment with opportunities to develop programming skills. The paper also includes comments from students that reflect the author's effectiveness as an educator in creating a supportive and challenging learning environment for engineering students.

KEYWORDS

supportive learning, engineering education, constructive feedback, problem solving, video solution, self-directed learning, flexibility, pedagogy, trusting environment

1 INTRODUCTION

Engineering education is essential for the development of new technologies and innovation, and it is a critical component of economic growth and social progress. However, engineering education can also be challenging and intimidating for many students. The success of engineering education is measured by the ability of students to apply theoretical knowledge to practical problems, and this requires a strong emphasis on problem-solving and practical application of knowledge. To achieve the highest quality of teaching, educators must create a trusting environment that allows students to feel comfortable asking questions and performing to the best of their abilities. However, creating an environment that supports and encourages students to develop these skills

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can be challenging. The challenges of engineering education go beyond academic rigor and technical skills. Students face various obstacles in their learning, including fear of failure, lack of confidence, and feelings of isolation and infinite number of possible engineering problems in practice. These factors can contribute to a negative learning environment that undermines students' ability to reach their full potential. By creating a trusting environment, educators can help students overcome these challenges and develop the confidence and skills needed to succeed in engineering.

In this paper, we explore pedagogical strategies for creating a supportive and effective learning environment for engineering students. The primary research problem is to identify approaches that address the challenges students face in their engineering education journey. By doing so, we aim to enhance student engagement and academic outcomes. To guide our investigation, we set forth the following research questions:

- How can educators create a trusting environment that empowers students to seek clarification and actively participate in the learning process?
- What are the most effective methods to provide early and constructive feedback to students, facilitating their academic growth and confidence?
- How can a safe and supportive learning environment be cultivated to reduce fear of failure and encourage risk-taking in engineering students?
- What opportunities can be offered to foster teamwork and collaboration among engineering students, and how does this positively influence their learning experience?
- How can programming skills be integrated into the engineering curriculum to enhance problem-solving abilities and prepare students for real-world challenges?

By addressing these research questions, the paper aims to shed light on the teaching philosophy and the pedagogical approach that have been adapted at Umeå University in Sweden for mechanical engineering program by the author who has the experience of teaching in several universities of Sweden and abroad. The author emphasizes the importance of creating a trusting environment that encourages students to ask questions, being available and providing early and constructive feedback, safe and supportive learning environment and offering opportunities for students to develop teamwork and programming skills.

In the following, we present the 'Methodology: the pedagogical approach,' followed by the 'Results: discussion of pedagogical values and outcome of student evaluations,' and finally, we conclude by summarizing the findings and implications for fostering effective engineering education.

2 METHODOLOGY: THE PEDAGOGICAL APPROACH

The author as a lecturer, first teaches students relevant theory and mathematical models, then moves on to textbook exercises, and eventually—maybe—gets to real-world applications. Beyond marks, the only reason students have to acquire the content is the nebulous promise that it would be useful later in the curriculum or in their professions. Failure to connect course content to the real world has repeatedly been shown to contribute to students leaving the sciences [1, 2].

In engineering courses, Problem-Based Learning (PBL) and problem solving are primary methods of learning for students [3–9]. A meta-analysis of the effectiveness

of problem-based learning was published by Dochy et al. [10]. Their findings imply that students may gain more knowledge in the short term when taught traditionally, but they are more likely to retain knowledge for a longer period of time when taught with problem-based learning. PBL teaching regularly outperformed other methods for skill improvement. However, relying solely on problem-solving sessions may not guarantee that students attain the desired level of proficiency in the relevant skills [11]. Some students may miss these sessions or lack the necessary preparation or updated knowledge to comprehend the solutions presented in class. Additionally, the limited lecture time restricts the ability to delve into the intricacies of every problem. Moreover, human motivation fluctuates [12, 13], and individuals may not always be in the optimal mindset for learning. This holds true for students as well. Consequently, it becomes crucial for instructors to facilitate learning during periods when students are motivated, even if it means studying at unconventional times such as midnight. To address this, the author voluntarily introduced and created detailed video discussions as part of the teaching methodology. The author created pre-recorded video content, accessible through the Canvas platform, enabling students to engage in pre-study before attending tutorials. This approach enhances learning by providing additional practice opportunities at home [14], effectively complementing the problem-solving aspect of engineering courses. Notably, the provision of comprehensive video solutions by the author for selected problems stands as a distinctive feature at Umeå University, considering the limitations of lecture time.

In the following it is explained how the author implements a pedagogical approach to maximize learning outcome for his students of mechanical engineering program.

The lecturer starts each session with a summary of previously discussed concepts and sets clear learning outcomes. He asks questions, encourages student participation, and celebrates students' knowledge. He also tries to leave a positive and lasting impression at the end of each lecture, linking the content to the final assessment (exam) or future career to motivate students [15]. In addition to these engaging strategies, the lecturer also incorporates a special element at the start of each lecture. By posing simple questions, he celebrates those students who have dedicated time to pre-study before the lectures. He also tries to be punctual. So, before starting lectures, when he waits for other students to join the class (also during short breaks), he talks with some students in person. For example, how is the course going for you so far? What are the trickiest and simplest parts for you? What is your favorite topic so far? Do you think we should change something? He collects some valuable information on how the lecture is going on? Is there a need to change and shift a gear?

The lecturer encourages students to ask questions and challenges them to think and not accept anything without knowing the reason behind it. He teaches students to question and analyze the principles and theories they encounter. He encourages them to ask "why" and seek logical explanations for the concepts they learn. The author has his own story of inquiry, and tells it to his new students. During his study period, the author vividly remembers a particular incident that left a lasting impression on him. He had mustered up the courage to ask a question in class, hoping to gain clarity on a confusing concept. He experienced a moment of vulnerability when he asked a question and was met with laughter from his peers. It was a disheartening moment that made him feel embarrassed and discouraged. However, his former teacher responded differently. The teacher turned to the rest of the class and posed the same question to them. Despite the initial mockery, none of the students knew the correct answer. The laughter quickly transformed into silence as they pondered the question at hand. This incident taught the author (as a student at that time)

an important lesson: the fear of being laughed at should never deter us from asking questions. Every student possesses a wealth of knowledge, but it's natural not to know everything. What may be known to one person might be unknown to another. Therefore, there is no need to judge or feel embarrassed if we don't know something specific! So, the author makes sure to transfer the message that seemingly simple or basic questions can be the most important and challenging. To achieve this goal, the lecturer strives to create a sense of community and belonging in the classroom. He pays attention to his students, listens to them, and makes them feel comfortable asking questions and performing to the best of his abilities. The author always keeps eye contact with students and faces the class when he uses power points. He moves around and pays equal attention to all of the students. During lectures, he shows that all students are important to him and that he cares about them. By paying students the attention they need, the lecturer understands students better and knows what works and what does not work or needs a change.

The author employs active learning strategies [16–19] and breaks up lectures with small tasks and discussions. In addition, he uses a variety of techniques such as changing his tone of voice, facial expressions, body language, and incorporating multimedia elements like videos or animations to make the learning environment interesting and maintain students' concentration lectures [20, 21]. The lecturer adopts a friendly attitude, making himself approachable and available for students. He provides quick and constructive feedback, answers questions promptly if they have arrived by emails, and offers support even outside of regular office hours. The aim is to ensure that students have continuous support and are not hindered in their learning progress (flexibility and availability [22] for students). Effective teaching requires that educators provide students with early and constructive feedback. The author prioritizes providing feedback that should be prompt and specific. This allows students to adjust their learning strategies and to develop a deeper understanding of course material. The author believes that feedback should be a dialogue between teacher and student, and that teachers should be available and approachable to answer student questions and obviously in a sandwich model [23–25].

The author has created comprehensive video solutions for engineering problems, consisting of nearly 200 problems across four courses. These videos enable students to study and practice at their own pace, even outside of lecture hours. This approach aims to facilitate learning by allowing students to engage with the material when they are motivated to study and in the right mindset (utilizing technology for self-paced learning) [12, 26].

The author has also introduced programming and report writing skills in the curriculum to address the needs of mechanical engineering students and prepare them for the industry and the challenges of the modern engineering workplace [27]. He prioritizes practical skills and incorporates hands-on projects to enhance student's teamwork and problem-solving abilities [28]. He focuses on the use of MATLAB [29] to solve practical problems and to explore the practical application of theoretical concepts. The author has found that by providing students with early exposure to programming skills, they are better prepared for the challenges of later coursework and for the demands of the modern engineering workplace (integration of real-world skills) [30, 31].

He also employs a randomized allocation approach to distribute students into groups. The students are advised to consider their potential future professional endeavors, wherein they may not have the autonomy to select their colleagues. Consequently, the students are encouraged to acquire the essential skills of effective

collaboration and teamwork, even in the presence of individuals they may harbor personal aversions towards within the classroom setting.

The author actively seeks feedback from students and colleagues to make improvements in his teaching. He is open to changes, attends pedagogical courses, and carefully selects learning resources to ensure the best possible learning outcomes for students. The author adapts his teaching practices to support students' needs in learning environments based on the feedback and anonymous course evaluations he receives. To show the effectiveness of the feedback, he highlights changes that have occurred in response to previous feedback at the beginning of each course to his students.

2.1 Data analysis

This study employed data analysis to explore the perceptions and feedback of students regarding their learning experiences. The data were collected through anonymous questionnaires returned by students, focusing on their evaluations of various aspects of the courses.

Specifically, the author reviewed 12 sets of course evaluations from the previous three years, involving an average of 40 students per class. The courses included in the analysis were the Introductory Course for Mechanical Engineering Students, Statics and Dynamics, Mechanics of Materials, and Machine Elements, totaling 240 sets of answers. The average response rate for these evaluations was 50%.

The questionnaire included a series of 16 questions addressing various aspects of the students' learning experiences, such as the overall course quality, the lecturer's treatment and enthusiasm, the amount of time spent on the course, the lecturer's contribution to the course, the availability of extra help, the lecturer's interest in student progress, the amount of assigned work, and whether students worked together with their peers during the course. Additionally, it inquired about the cooperation and communication between the course lecturer and students, the consideration of students' points of view during the course, and the adequacy of the course assessments. Moreover, students were encouraged to provide their own feedback, suggestions, positive aspects to retain, areas needing improvement, and any other viewpoints not covered in the above questions.

The qualitative data obtained from the questionnaires were carefully analyzed, and the results related to the outcomes of the questionnaire and the feedback received from students will be presented in the results section of the paper. This data analysis provides valuable insights into students' perspectives on the learning environment and the effectiveness of the pedagogical strategies employed, which will contribute to our understanding of creating a supportive and effective learning environment for engineering students.

3 RESULTS: DISCUSSION OF PEDAGOGICAL VALUES AND OUTCOME OF STUDENT EVALUATIONS

The pedagogical value of the described teaching strategies is multifaceted and can contribute to enhanced learning outcomes for students. Here are some key aspects that highlight the pedagogical values. In addition, some students' evaluation outcomes, enclosed in double quotation marks and italic format, have also been provided (with original typos!).

3.1 Adaptable teaching: fostering student-centered learning and continuous improvement through feedback integration

To create a trusting environment, educators must be flexible and responsive to student needs. A lecturer should be able to shift-gears and adjust teaching approach when there is a need. By adapting teaching practices based on both feedback and anonymous course evaluations, the author ensures that the specific needs and preferences of his students are addressed. This adaptability fosters a supportive learning environment where students feel heard and valued. Furthermore, by openly highlighting the changes made in response to previous feedback at the start of each course, the author promotes transparency and accountability, instilling confidence in students that their feedback can bring about meaningful improvements. This pedagogical approach not only enhances the overall learning experience but also cultivates a sense of collaboration, trust, and engagement between the author and his students.

3.2 Active engagement and participation

By starting each session with a summary of previously discussed concepts, the lecturer helps students review and reinforce their understanding. Additionally, by asking questions and encouraging student participation, the lecturer promotes active engagement, which enhances students' critical thinking, problem-solving skills, and knowledge retention.

3.3 Clear learning outcomes

Setting clear learning outcomes at the beginning of each session provides students with a roadmap for their learning journey. This clarity helps them focus on specific objectives and understand the expectations for that particular class. Clear learning outcomes also facilitate assessment alignment, ensuring that students are aware of how the content relates to future assessments or their future careers.

3.4 Motivation and relevance

Linking the lecture content to final assessments or future careers serves as a strong motivator for students. This linkage demonstrates the practical application and significance of what they are learning, helping students understand the relevance of the material and fostering a sense of purpose. By emphasizing the practical relevance, the lecturer inspires students to actively engage in the learning process and strive for excellence in their academic and professional pursuits. This approach leaves a lasting impression and enhances students' understanding while promoting their motivation and dedication to their educational and career goals.

3.5 Recognizing and celebrating student efforts

By incorporating a special element at the start of each lecture to acknowledge students who have dedicated time to pre-study, the lecturer recognizes and celebrates

their commitment to learning. This recognition can enhance students' motivation, self-esteem, and sense of achievement. The approach creates a positive atmosphere that motivates students to further explore the subject matter. It has been observed that students who actively engage, particularly in group work, tend to achieve better results. Notably, there have been instances where a few students who initially struggled to meet minimum requirements in the basic Introductory Course for Mechanical Engineering Students went on to excel in subsequent courses, earning high grades and emerging as top performers. The author attributes this success to the effectiveness of encouragement and acknowledging the students' knowledge and remarkable progress.

3.6 Consolidation and connection of knowledge

Providing concise summaries of previously discussed concepts at the beginning of each lecture helps students consolidate their understanding and reinforce connections between different ideas. This practice ensures a smooth transition between topics and promotes knowledge integration and a deeper understanding of the subject matter.

3.7 Student-centered approach

By giving students time to think and ask questions, the lecturer adopts a student-centered approach that encourages independent thinking and active participation. This approach values students' knowledge and perspectives, even when the answers may not be perfect. It creates a supportive and inclusive learning environment where students feel comfortable expressing themselves and engaging in intellectual discussions.

3.8 Courtesy and respect for student questions

Treating students' questions with courtesy and respect, regardless of their complexity, fosters a positive and inclusive classroom atmosphere. By repeating the questions and answering them in a way that acknowledges their value, the lecturer promotes a culture of curiosity, critical thinking, and open dialogue. This serves a twofold purpose. Firstly, it ensures that the lecturer has fully understood the question, allowing for a more accurate and relevant response. Secondly, this repetition of the question reassures all students in the classroom that they can hear and understand what was asked, fostering an inclusive and supportive learning environment. One student wrote *"The teacher always posed thoughts and questions; he made the course fun, and you wanted to learn. Fantastic, good teacher."*

3.9 Building a sense of community and belonging

The author's approach of valuing and paying attention to students' questions helps create a sense of community in the classroom [32]. By actively listening to students, maintaining eye contact, and treating all students as important, the author establishes a connection and conveys care and respect. This sense of belonging

enhances student engagement, motivation, and overall well-being, contributing to better learning outcomes. Students wrote "*I think that your attitude toward us as students is one of the greatest things. You listen to us, and you are almost always available to answer our questions!!*" and "*Keep up the good work you are doing, and I really hope that you will be available for my thesis next year!!*"

3.10 Monitoring and adjusting teaching strategies

By observing students' eyes, reactions, and movements, the author gains valuable insights into the effectiveness of the lecture. This non-verbal feedback allows the author to assess student engagement and understanding, identify what works well, and make necessary adjustments or improvements to teaching methods. This continuous monitoring helps ensure that the lecture remains engaging, dynamic, and relevant to students' needs.

3.11 Incorporating active learning strategies

Recognizing the potential for boredom during long lecture sessions, the author incorporates active learning strategies to break the monotony and enhance student engagement. By incorporating tasks like discussions with peers, reading handout material, or applying concepts to problems, the author promotes student interaction, critical thinking, and self-reflection. These strategies facilitate deeper understanding, correction of misconceptions, and the development of problem-solving skills.

3.12 Effective communication techniques

The author utilizes various communication techniques to enhance clarity and direction in the delivery of important concepts. By using changes in tone of voice, facial expressions, body language, and emphasizing specific words, the author captures students' attention, arouses their curiosity, and encourages them to seek answers to their own questions. These techniques make the content more engaging, memorable, and conducive to active learning.

3.13 Engagement and interest

By incorporating funny slides, videos, or animations related to the lectures, the author adds an element of humor and novelty to the learning environment. This helps to prevent lectures from becoming boring and captures students' attention. It restores concentration levels and makes the learning experience more enjoyable and engaging, ultimately facilitating better learning outcomes.

3.14 Maintaining student focus

By strategically following up something funny with an important point while students are still attentive, the author ensures that key information is delivered when

students are fully engaged. This technique helps to maintain students' focus and reinforces important concepts, making the learning process more effective.

3.15 Monitoring and adapting to student needs

The author actively monitors the students and recognizes when they are tired. By giving them short breaks, the author acknowledges the importance of rest and refreshment for optimal learning. These breaks provide students with the opportunity to review their notes, ask questions, and rejuvenate their minds, resulting in improved learning retention and understanding.

3.16 Breaking up lectures

Breaking lectures into parts with lighter moments interspersed between tougher sections helps to alleviate the potential monotony of lengthy sessions. This practice provides variation and relief for students, preventing mental fatigue and enhancing overall engagement throughout the lecture.

3.17 Friendly and approachable attitude

By expressing a friendly and approachable demeanor, the author establishes a positive classroom atmosphere. This attitude motivates students to learn and feel comfortable asking questions. The author's availability and openness create a supportive environment where students feel valued and encouraged, leading to increased participation and active involvement in the learning process [22].

3.18 Equality and respect

The lecturer listens to and cares equally about all students, demonstrating a fair and respectful approach. This promotes inclusivity and creates a sense of equity within the classroom. By treating students with respect and valuing their contributions, the author fosters a positive and collaborative learning environment where all students feel valued and empowered.

3.19 Effective classroom leadership

While promoting a friendly environment, the author maintains the role of the leader in the teaching and learning process. This leadership ensures the smooth progression of the class, facilitates the acquisition of knowledge, and guides students towards achieving the learning objectives. One student wrote, "*I just simply would like to say thanks for the courses in Strength of Material and Machine element. You have been fantastic and most of all shown an amazing commitment as a teacher I have not seen since my studies began at Umeå university. My knowledge in this area has increased exponentially, and all thanks to you. This branch of a mechanical engineer portfolio seems at first very complicated, but you successfully managed to guide us through this jungle (Like a boss!)*".

3.20 Creating and fostering a safe and supportive learning environment

By sharing a personal story and own experience of being laughed at when asking a question, the lecturer highlights the importance of creating a classroom atmosphere where students feel comfortable and safe to ask questions and participate actively. This fosters an inclusive and supportive learning environment that encourages all students to engage and perform to the best of their abilities. Indeed, the story emphasizes the need to create a classroom environment where students feel safe and supported in their pursuit of knowledge. By showing the teacher's positive response to the author's question (at the time he was student), it underscores the importance of nurturing an atmosphere of respect and understanding. Such an environment allows students to take risks, express themselves, and learn from each other without fear of judgment.

3.21 Embracing diversity of knowledge

The story highlights the idea that every student possesses a unique set of knowledge and experiences. It encourages an appreciation for the diversity of knowledge within the classroom. Recognizing that everyone has something valuable to contribute helps foster a collaborative and inclusive learning environment.

3.22 Cultivating resilience and perseverance

The story conveys the importance of resilience in the face of challenges or setbacks. It teaches students not to be discouraged by initial difficulties or the fear of being laughed at. By demonstrating that even the teacher didn't have an immediate answer, the story encourages students to persevere, seek answers, and learn from their mistakes.

3.23 Promoting empathy and understanding

In addition, the story promotes empathy and understanding among students. It emphasizes that what may be known to one person might be unknown to another. This encourages students to approach their peers' questions or gaps in knowledge with empathy and a willingness to support each other's learning.

3.24 Availability and prompt response

The teacher's availability and responsiveness to student questions are crucial for effective learning. By being approachable and accessible even outside of regular office hours, the lecturer ensures that students receive timely assistance and clarification. This reduces potential barriers to learning, saves time, and maintains students' motivation and engagement. Students' acknowledgements are reflected in the course evaluations as a positive parts of the course: *"It was an interesting course and the teacher should be praised for the amount of work he made outside of office hours and during the weekends." "Fast and good response on questions", "The tutor's engagement and communication." "The teachers commentary*

was insightful", "The explanation and availability to the material and the teacher." "That you got fast answers from the teacher when you needed even if the situation is extraordinary and distanced." "Contact with the teacher has worked smoothly even with the Covid situation." "*He almost instant answer so that we don't have to wait 1 day to keep on with the question*", *"Your instant response on Email with detailed answers, even outside working hours! Is a huge plus*", "*He is doing an amazing job! Really takes the time to help the students" and "it was an interesting course and the teacher should be praised for the amount of work he made outside of office hours and during the weekends*".

3.25 Addressing conceptual gaps

Understanding foundational concepts is essential for students to grasp more complex ideas. By promptly addressing students' questions and helping them overcome difficulties in understanding basic/original concepts, the lecturer ensures that students can progress effectively in their learning journey. This prevents knowledge gaps from impeding further learning and encourages students to actively engage with the course material.

3.26 Early personalized and constructive feedback and support

Effective teaching requires that educators provide students with early and constructive feedback. The lecturer provides timely feedback on students' assignments, which is crucial for their learning and improvement. By offering constructive criticism within a sandwich feedback form (starting with positive comments, then addressing mistakes), the teacher fosters a supportive learning environment. This approach helps students understand their strengths and weaknesses, encourages self-reflection, and motivates them to continue growing and developing their skills without being stopped for a long time until they got an answer. Late feedbacks increase the risk of losing learning motivation.

3.27 Learning by doing—Problem solving

Problem-solving sessions allow students to apply theoretical knowledge to real-world scenarios, bridging the gap between theory and practice. Engaging in problem-solving exercises develops critical thinking skills, encouraging students to analyze, evaluate, and find innovative solutions to complex problems [28, 33]. It also promotes active learning, where students take an active role in constructing their understanding by actively engaging in the problem-solving process. Problem-solving sessions often involve group work, fostering collaboration and communication skills as students work together to solve problems, share ideas, and explain their reasoning. Further, these sessions help students develop transferable skills such as logical reasoning, analytical thinking, creativity, and problem-solving abilities that can be applied beyond the specific engineering context. Learning through solving problems enhances student engagement and motivation as they are actively involved in discovering solutions and seeing the practical relevance of their knowledge.

3.28 Flexibility in learning opportunities

Recognizing that students have different learning preferences and circumstances, the teacher introduces the use of detailed video discussions and solution manuals. These resources allow students to study at their own pace, even outside traditional lecture hours [26]. By providing recorded video content and access to detailed solutions, the teacher offers flexibility and the opportunity for students to engage in self-directed learning, practice problem-solving, and consolidate their understanding independently [26, 34, 35]. Students wrote "*The recorded solutions is fantastic, you can go throw them in your own tempo.*" "*The recorded video solutions to the selected problems was really good, as a student you can pause and think about the problem if u don't wanna watch the whole solution at once. more lecturers should use this in their teachning. Very good!*"

3.29 Enhancing motivation and self-directed learning

By making detailed video solutions available and allowing students to challenge themselves before accessing them, the lecturer promotes student motivation and self-directed learning. This approach empowers students to take ownership of their learning process, choose when and how to engage with the material, and develop a deeper understanding of the concepts at their own preferred pace. One student wrote, "*The video solutions for the problems are perfect because you can watch them when you are stuck and pause when you've got what you need to become unstuck on the problem.*"

3.30 Going the extra mile

The lecturer's dedication and commitment, investing a few hundred hours of extra time to produce detailed video solutions for engineering problems, exemplify a strong commitment to students' learning. This level of effort demonstrates the lecturer's passion for quality teaching and creating optimal learning opportunities for students. This voluntary work has got many acknowledgments such as, "*The video solutions are gold worth, I understand that it takes a lot of time for the lecturer to make these but I think the university should encourage teachers who want to make these. When you are repeating or have problems you don't understand or get the wrong answer, the video solutions you can go and look at the problem in your own speed.*" "*The video solutions are very good and helpful both in getting unstuck on a problem and for review*", "*The video solutions have been really helpful. They showed me how to approach certain problems in a good way and the teachers commentary was insightful.*" "*Overall the examples and suggested examples to practice have been explained in a very thorough way, not skipping to many steps etc, this is very good and helps a lot with the understanding*", "*The communication and the time spent to make all the video solutions are fantastic.*" "*You are a great teacher in prerecorded videos! Those are great.*" "*So helpful to have all the videos available so that one can go back and get an explanation if something has been forgotten*".

3.31 Addressing identified skill gaps

By recognizing the lack of programming skills and report writing abilities among mechanical engineering students based on feedback from companies,

the lecturer takes initiative to improve the introductory course for mechanical engineering. Introducing MATLAB programming and lectures on report writing from the beginning of the program helps students become familiar with these skills early on. This approach ensures that students develop essential competencies that are relevant to their future careers, enhancing their employability and practical problem-solving abilities.

3.32 Inspiring and motivating students

The inclusion of MATLAB programming and report writing in the first course of the mechanical engineering program (introductory course for mechanical engineering) inspires students to explore and predict results using programming. This hands-on approach encourages students to engage actively in their learning, promoting a deeper understanding of the subject matter and fostering enthusiasm for the field. The improvement observed in students' programming and simulation skills, as well as their ability to produce good reports, indicates the effectiveness of this approach.

3.33 Peer collaboration and teamwork

Encouraging students to work in teams and cooperate with each other, even if they have differences, develops their collaborative skills and prepares them for real-world working environments. Group projects provide opportunities for students to learn how to navigate conflicts, communicate effectively, and leverage diverse perspectives to achieve shared goals. This prepares them for future professional settings where teamwork and collaboration are essential.

3.34 Promoting collaborative skills and adaptability for future career success

By emphasizing the significance of learning to work effectively with diverse individuals, including those with whom they may not necessarily get along, the lecturer imparts a valuable life lesson. The intention behind this approach is to equip the students with the essential skills needed for successful teamwork and collaboration in their future careers. Through this exercise, the students are encouraged to embrace the challenges that arise from working with different personalities and perspectives. It serves as an opportunity for them to cultivate important interpersonal skills such as adaptability, communication, conflict resolution, and empathy. By instilling the mindset of collaboration early on, the lecturer prepares the students for the realities of professional life, where they may encounter colleagues towards whom they might not naturally gravitate. The intention is to enable them to navigate these situations with maturity, professionalism, and a focus on achieving shared goals.

3.35 Personal engagement and feedback collection

Taking the time to engage in informal conversations with students before lectures and during breaks demonstrates a personal and caring approach. By asking students about their experiences, difficulties, and preferences, the lecturer collects

valuable feedback and gains insights into the effectiveness of the course. This information helps to identify areas that may need improvement, allows for timely adjustments, and ensures that the learning experience is tailored to meet the students' needs. Students wrote "*The enthusiasm that you have is something that you should keep! It's always really nice when the lecturer is interested in the subject and interested in being sure that the students will be able to get a good grade and not fail! Really refreshing to see that!*" "*I can see how you are exited and want to help, you actually care about what you are teaching. This is very nice.*" "*I think the amount of work you put into the course is amazing. Solving every assignment and helping whenever there is a question. Great course*".

3.36 Punctuality and adaptability

Being punctual and using waiting time before lectures or during breaks to interact with students reinforces a sense of respect, approachability, and attentiveness. It creates an open and supportive classroom environment where students feel valued and heard. Additionally, actively seeking feedback on the course and being open to change and adaptation based on student input shows a commitment to continuous improvement and responsiveness to student needs.

3.37 Reinforcing learning outcomes

By ending each lecture with fundamental but simple questions, the lecturer assesses how well students have achieved the learning outcomes. This approach helps students gauge their own understanding and reinforces the key concepts covered in the lecture. It also provides an opportunity for students to reflect on their progress and identify areas that may require further attention. By emphasizing the learning outcomes, the lecturer highlights the importance of actively engaging with the material and encourages students to take ownership of their learning.

3.38 Demonstrating the value of attending lectures

By ending the lecture in a way that helps students feel the added value of being present in the classroom, the lecturer motivates students to actively participate and follow up on the lecture material. Linking the lecture content to the final assessment highlights the relevance and practical application of the material, making it more meaningful for students. This approach encourages students to see the lecture as an important and interesting occasion, rather than merely relying on downloaded materials. It fosters a sense of engagement and investment in the learning process.

3.39 Promoting exam preparedness

By showing samples of previous exam questions that require knowledge from the current lecture, the lecturer highlights the connection between lecture content and the final assessment. This helps students understand the relevance of the material and prepares them for the types of questions they may encounter in the exam. By demonstrating that the current lecture material makes the exam questions easier,

the lecturer increases students' confidence and motivation to study the lecture content thoroughly. This approach also encourages students to take diligent notes and engage actively during the lecture.

3.40 Increasing attention and note-taking

By structuring the end of the lecture to include important questions and exam-related discussions, the lecturer captures students' attention and promotes active note-taking. Students are more likely to be attentive and engaged when they see the immediate relevance of the material to their assessments. Encouraging students to write down important points or explanations reinforces their understanding and helps them retain the information for later review and study.

4 CONCLUSION

The pedagogical strategies discussed in the paper contribute to enhanced learning outcomes for engineering students. The author emphasizes adaptability, active engagement, clear learning outcomes, motivation, recognizing student efforts, consolidation of knowledge, student-centered approach, respect for student questions, building a sense of community, monitoring and adjusting teaching strategies, active learning, effective communication, maintaining student focus, and promoting a safe and supportive learning environment. These approaches create a positive and inclusive classroom atmosphere, foster student motivation and engagement, and promote effective learning. The author's availability, prompt response, addressing conceptual gaps, early feedback, problem-solving sessions and videos, flexibility in learning opportunities, and dedication to going the extra mile further enhance the learning experience. Overall, these pedagogical values and student evaluations demonstrate how the author's approach creates a supportive and effective learning environment for engineering students. However, like any pedagogical approach, it is not without its challenges. Some of the challenges faced in implementing this approach include:

- **Time and Effort:** Creating comprehensive video discussions, detailed solutions, and additional learning materials requires a significant investment of time and effort from the educator. Recording and editing videos, producing materials, and addressing various student needs can be time-consuming and may impact the educator's workload.
- **High Expectations:** Providing continuous support and prompt feedback to students can lead to heightened expectations from them. Students may anticipate immediate responses to their queries, which can put pressure on the educator to be constantly available and responsive.
- **Unequal Implementation:** Not all educators may have the resources or time available to implement this approach at the same level. Students in other courses or with different instructors may perceive differences in teaching methods, which could lead to varying learning experiences.
- **Balancing Workload:** Managing the workload of preparing video discussions, conducting lectures, and providing individual support requires careful balance. Ensuring that the quality of teaching is maintained across all aspects of the course can be challenging.

- **Adaptability to Larger Classes:** Scaling this approach to larger class sizes may pose challenges. With more students, providing individualized attention and support becomes increasingly difficult.
- **Technology and Access:** While self-paced learning through videos is beneficial, some students may face technological barriers or limited access to the required resources, affecting their ability to fully engage with the material.
- **Student Engagement:** Despite the availability of video materials and additional resources, ensuring student engagement and motivation remains essential. Some students may struggle with self-directed learning, which may impact the effectiveness of the approach.
- **Collaborative Group Dynamics:** The randomized allocation of students into groups may result in varied group dynamics. Managing conflicts or ensuring effective collaboration within diverse groups could be a challenge.
- **Adapting to Feedback:** Actively seeking and incorporating feedback from students requires continuous effort. Making timely adjustments based on student feedback may necessitate adaptability in teaching strategies.

Despite these challenges, the pedagogical approach presented in this study strives to overcome them and deliver an effective learning experience for engineering students. By acknowledging and addressing these challenges, educators can better support students' needs and continuously improve the quality of teaching.

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