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ASSESSING ENGINEERING SURVEY COURSE OUTCOMES THROUGH GRADE DISTRIBUTION ANALYSIS

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Abstract:

Engineering Survey are core courses for freshmen in engineering education and provide essential science, technology and comprehensive knowledge. The purpose of this study was to examine the relationship between grade distribution patterns and course performance in these classes from 2020-2023. Academic data analysis showed a pattern of high (A–B) grades in the early years, typically involving theoretical understanding as well as some level of practical skills and report-writing. But there is a marked movement towards weaker gradings (B- to D+) in 2023, which could be indicative of new pressures at play - perhaps down to alterations in how the course is being delivered or less practise. These findings bring home the fact that better pedagogical techniques and more hands-on experience are needed to combat these issues in order to improve the educational outcome for Engineering Survey courses.

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Grade Distribution, Engineering Survey, Student Performance, Educational Outcomes, Surveying Education

Introduction

Undergraduate engineering education puts more weightage to the survey courses for various aspects since this will provide essential understanding and practical skill for evaluating or mapping of physical environment. These courses give the young engineers a thorough knowledge about survey principles in various fields which will be beneficial to them when they get on-field. Courses in Engineering Survey are often evaluated for effectiveness based on several indicators, including student test scores and overall performance. The grade distribution tells how well students understand the course and meet its learning objectives. Consistent high grades for a cohort of students may be evidence that the group has achieved an honest standard, with nothing to indicate otherwise. Lower grades suggest that there are course, educational approach or student engagement concerns.

The evaluation of the student's progress in engineering education especially focused on academic achievements is seen as most important for engineers. In their study, Dym et al., (2005) looked at the necessity of including engineering design principles in an assessment system for both classroom-based performance and team-design (formative or summative). It was proposed by the authors to a comprehensive evaluation model in Engineering Education should encompass problem framing, innovative idea generation and rapid prototyping through multiple iterations. This not only helps to assess the ability of students in meeting real-life engineering problems; it also promotes effective collaborative work and application of theoretical concepts to actual case studies. Brophy et al. (2008) studies the directions under which problem-solving can become more effective with design projects, diagnostic assignments and analytical exercises within engineering education. They wrote that these types of efforts are crucial to developing the critical thinking skills and adaptive expertise needed from engineering students. The authors concluded that the observed-practical skills with this tool in undergraduate engineering education is likely to improve cognitive competency, hand-on experience and their status for industry-ready from graduation posts. And experiential learning was the need of hour along with practical hands-on experience for assessing engineering students which resulted from those two studies. A holistic framework for evaluation of engineering capabilities in higher education systems could help to conduct a well-rounded, greater insight towards the comprehensive assessment ability that can lead to engineers who are future ready, and skill based.

Traditional assessment tools may not fully capture a student's capabilities, particularly in soft skills like communication and teamwork. Incorporating alternative evaluation methods, such as peer assessments and project-based evaluations, provides a more comprehensive view of student performance (Lasassmeh, 2024). The use of assessment methods like oral assessments encourage greater involvement and perseverance amongst an engineering group (Kuzmin, 2018). Oral examination provides an environment that is dynamic and interactive where the students can demonstrate their understanding, analytical reasoning abilities live. It is a way to test the understanding of students and if they are good at communication skills, which would be major when it comes to being an engineer! They also suggest that the introduction of oral

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exams could improve academic performance. Schorr (2022) findings supported the conclusion that success in lower-division courses, particularly during the first year of study had a significant influence on an engineering student's likelihood to persist. These are typically the initial courses taken by beginners covering such topics as mathematics, physics and basic engineering principles. This foundation is important for better participation in advanced engineering courses. According to Wilkins et al. (2021) the data confirms a connection between strong performance on early mathematics courses increases the likelihood of earning an engineering degree. Students who are engaged in their curriculum and well-prepared for the early fundamental courses, especially around math (physics can be recoverable) will go on to become engineers. Moreover, utilizing assessment tools besides oral exams among engineering disciplines could contribute to enhance student performance. It seems pretty clear that engineering students who engage in their studies and do well in the introductory basic courses, especially math are more likely to persist and be successful on their way through an engineering program. Educators may also be able to deliver a broader composite evaluation of students' performance if they supplement traditional assessments with interactive tools such as oral exams which, in turn, can foster both appointment and persistence.

The background of engineering graduates might also matter in terms on their career progression as argued by Alam & Forhad (2021). Sociological research has shown that students who come from the bottom half of society are more likely to face these barriers in their learning and career trajectories. Benitz & Yang (2021) found increases in student learning occurred alongside the transfer of important skills. The research found that participation in community-based interventions enable engineering students to apply their theoretical learning into practice, thereby leading to the development of skills like working collaboratively as a team at diverse places (either partners or clients), communicating effectively and solving problems efficiently. For instance, Vogt (2008) emphasized the importance of faculty members to student retention and performance in engineering curriculum. Their teaching style and guides will affect the academic success, persistence of students. The study showed that building a strong academic ecosystem is premised on great faculty-student relationships, responsive pedagogy and being student oriented/supported. What the data reveals is that success among engineering students and practitioners in these classes appears to reflect a combination of factors, including social determinants as well as practical educational exposure with helpful programming support by faculty. The study results show that the success of both engineering students and professionals depends on a holistic approach to engineering education, which includes addressing social adversity factors; providing opportunities for experiential learning experiences within classrooms or out-of-class settings; fostering relationships between faculty members, staff at all levels in higher educational institutions who have regular contact with undergraduates (and their student colleagues), as well as mentors from industry. For educators or policymakers looking to create an environment that supports different student cohorts and promotes engaged learning, this is an approach they should bring into engineering curricula as well as institutional protocols.

Irregularities in grade distribution have been one of the primary difficulties facing undergraduate engineering education due to a perceived inability for the grading system alone to accurately assess performance by students. Naturally, this lack of hands-on learning is also leaving students ill-prepared for the demands in industry. Retention is often impacted by early academic performances, specifically in things like math and can be a competitive disadvantage to late bloomers. Assessment is one of the orals main strengths, which can leave gaps in what

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students are learning such as poor communication and analytical reasoning skills. Numerous other socioeconomic obstacles are directly in the way of learning and career progression, with many students originating from disadvantaged surroundings missing out on resources to conform them or backstop their scholarly career. Faculty-student engagement is also important; lack of mentorship and advising can result in lower completion rates especially for students who would benefit from strong academic connections. The objective of this paper is to analyse the grade distribution of engineering students over the years, identify trends and patterns in student performance

Overview of the Course

Surveying is very important in the field of civil engineering as it helps collect data to plan and perform any kind of construction project. It was a request for the curriculum to introduce trainee surveyors to various tools of the trade including prismatic compasses (for bearing) and levels (elevation). With these tools the hands-on training is expected to give students practical knowledge of instruments and impart essential skills required for accurate field work or setting out, marking planned structure's locations on the ground.

This course is offered to Year 1 students of the Bachelor of Engineering (Hons) Civil (Infrastructure) program at Universiti Teknologi MARA Cawangan Pulau Pinang. This is a 3-credit hour course and categorised as embedded course. This because the course designation is lecture and laboratory. Shown in Table 1 is the designation course outcomes.

Table 1: Engineering Survey Course Outcomes

Programme Learning Outcomes (PLO)	Course Outcomes (CO)	Description
PLO6	CO1	Apply engineering survey theories and fundamentals to solve civil engineering survey problems.
PLO2	CO2	Use appropriate survey techniques, resources and modern survey equipment in civil engineering survey works.
PLO5	CO3	Present civil engineering survey works through written reports.

The presented data Table 1 describes the course outcomes (COs) and their corresponding program outcomes (PLOs) in accordance with the guidelines of the Malaysian Ministry of Higher Education (MOHE). In the case of CO1, students are tasked with the application of engineering survey theories and fundamentals to address civil engineering survey challenges, aligning with PO2 and PLO6 (cognitive domain level 4: Analysis). This particular result is delivered through instructional sessions and evaluated solely through a final assessment, representing 60% of the evaluation for this outcome.

CO2 centres on the utilization of suitable survey methodologies, resources, and contemporary survey apparatus in civil engineering survey projects, matching with PO5 and PLO2 (psychomotor domain level 4). This outcome is facilitated via interactive laboratory sessions and appraised through a practical examination, contributing 30% to the overall evaluation.

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With regards to CO3, students have display of civil engineering survey projects in the form written documentation linked with PO10 and PLO5(Affective domain level 4). This is also achieved with the 10% of hand-on lab sessions written up in a laboratory notes book and observed when appropriate stand over competency signs off by donnies.

The assessment distribution of these results is usually divided into 30% exams, practical (10%) and final assessments (60%). This framework ensures that students are comprehensively assessed in terms of applying their theoretical understanding and experiencing the application, practices with modern techniques and equipment to experiment things theoretically being mentioned, effectively writing a report on the research done.

Methodology

Grade data of the students who enrolled in Engineering Survey from years 2020-2023. The data came from the Ufuture scheme. The system function comprises academic tracking system used by the university which tracks student learning activities and assessment progress. The use of Microsoft Excel enabled trend analysis to be performed aiming at observing how student performance has fluctuated over the years comprehensive statistical tests and analyses were implemented via JASP (an open-source software).

Data Collection

Grade data was extracted from the Ufuture platform which held a student transcript of achievement in Engineering Survey course (2020 through 2023). Specific academic scores of each student for every academic year - It was making our dataset to be predicted and measured based on patterns over a period of time.

Trend Analysis

Trend analysis was performed with Microsoft Excel. Grade data was then organized and displayed as line plots to investigate potential student performance trends across the four-year span (compared with grade distribution from each year).

Statistical Analysis

Statistical analysis was conducted using Jeffreys's Amazing Statistics Program (JASP), an open-source statistical software. The analysis aimed to describe how grades were distributed to find how grades were described in the years and compute descriptive statistics (e.g., mean, median, standard deviation) for each year.

Calculation Details

In order to understand the grade distribution, mean is calculated for each year to get a sense of the overall performance. Then median to see the middle point in the distribution, which gives a more accurate picture when there are extreme outliers. Finally, the standard deviation to measure how spread out the grades were from the average in each academic year was calculated. These techniques were applied in the study to perform an extensive analysis of student performance patterns and causes that could affect these patterns.

Results and Discussions

The course centred around three fundamental areas: comprehending survey theories, utilising state-of-the-art equipment, and delivering surveys through reports. Analysing grade data from

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2020 to 2023 allows for the identification of noteworthy patterns in student performance and the extent to which the course achieves its objectives.

Looking at the grades from 2020 to 2023 shown in Figure 1, it is clear that student performance in Engineering Survey courses is going downhill. In 2020 and 2021, most students performed well, mostly in grades A to B.

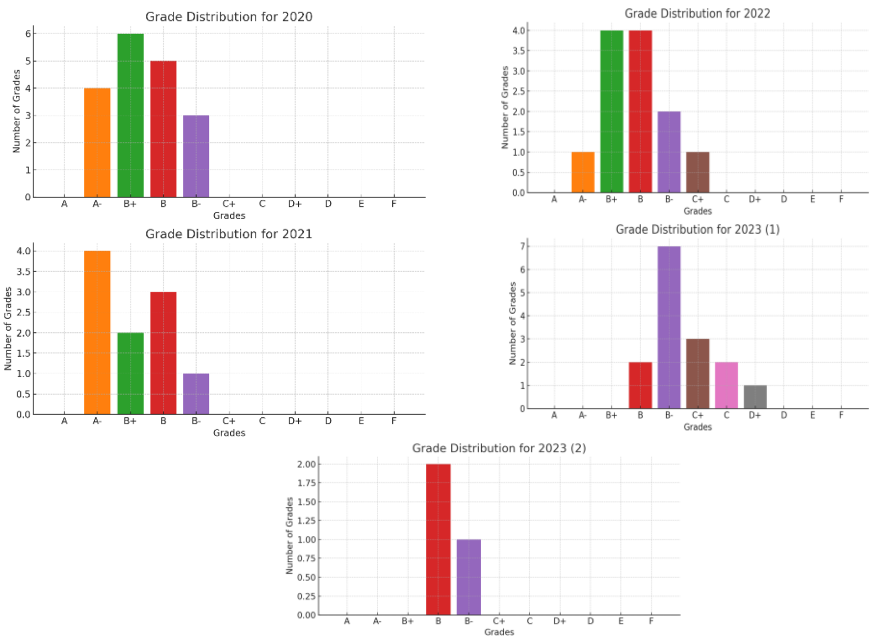

Figure 1: Grade Distribution for Each Year

The largest decrease in grades occurred between high and low performance, which echoes the evidence from academic literature on psychosocial elements (e.g., of engagement or achievement) that influenced student behaviour. For example, Morrison et al., (2012) talked about the performance along with significant roles of motivation as well another influence social pressure. These variables were all strong predictors of low attainment, with the implication that for many students less good examination performance might be attributable to generic psychosocial pressures rather than (as it is often assumed) relatively fixed by cognitive ability.This could mean students who also see a decrease in motivation and academic performance (potentially due to increased stress or decreased peer support from more competition), which leads them into the lower categories of grading. These psychosocial elements might be adduced to explain the continuing downward spiral in grades, thus reminding educators that it takes more than instruction actual context but also teaching support and emotional or social resources shaping within their pedagogical boundaries.

Examining the Engineering Survey results for the years 2020–2023 reveals an unsettling pattern, as depicted in Figure 2. Most students thrive in 2020 and 2021 and receive numerous As and Bs. It seemed that the course was doing a great job, teaching them what they needed to know. By 2022, things will begin to slip slightly. Fewer students received top marks, and there was a wider range of grades, including some C + grades. This suggests that the course

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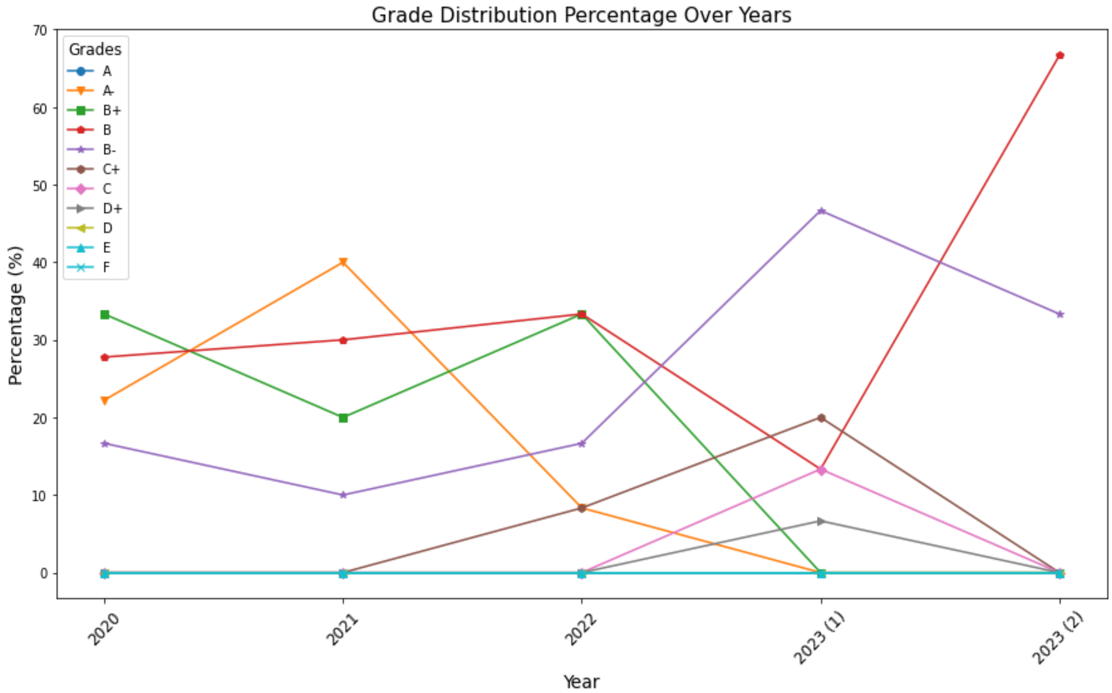
was perhaps not working as well as it had been. However, real problems occurred in 2023. The first group of students that year really struggled, with most getting B's or lower, and many even ending up with C's or D's. This is a big difference compared to earlier years and is worrying. The second group also had lower grades, mostly B's and B's, which confirmed that something was off.



The drop in 2023 suggests the need for enhanced teaching methods or more support in understanding fundamental concepts. Lower grades in 2023 could imply reduce hands-on opportunities, possibly due to external factors such as changes in course delivery methods (e.g., remote learning impacts). Wong & Lim (2023) stated in their research paper that e-learning generally improves academic performance due to increased flexibility and access to resources, but it also highlights challenges such as technical difficulties and the need for self-discipline. In essence, while e-learning can be beneficial, it's not a one-size-fits-all solution and requires careful implementation to maximize its potential. The decline in 2023 suggests that students had less practice or feedback on written reports, which affected their performance. The decline in student performance from 2020 to 2023, characterized by fewer students achieving top marks and more receiving lower grades, suggests a need for enhanced teaching methods and support.

Potential factors contributing to greater numbers of engineering survey course students experiencing academic decline from 2020-2023 are related to instructional approach, student engagement, and support services. Changing instructors and teaching assistants could have led to differences in quality of instruction, as well as less effective deployment of new methods and technology that might not work over the internet. In the longer term Schorr (2022)has suggested that altering our teaching frameworks to match with how students learn now might offer some recourse, especially by providing individual instruction for formal methods comprehension.

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The Covid-19 pandemic came and virtual learning during the early part of 2020, an era where it can be assumed engagement starting dwindling. In addition to the higher academic demand over an extended time without peer interaction, students told me that other societal issues such as financial struggles or difficult home environments made it impossible for them to focus and succeed in coursework. However, technical barriers hampered learning through unreliable internet connections and obsolete devices in use. Related to inequalities of access, Wong & Lim (2023) raises the point that if not managed well this digital divide may serve as one other challenge causing disadvantage to some students. Abdul Rasid & Mustapen (2023) evaluate obstacles like poor connectivity of students and the difficulties related to online assessment.

Furthermore, these difficulties highlight the importance of continued teacher training and varied instructional methods. Research by (Wang & Qing, 2023) suggest that the combination of technology and instructor activity has been shown to improve student satisfaction, as well academic performance. By promoting interactive and collaborative learning opportunities alongside mental health support, societal pressures that exist in the external world can be prevented from spilling on to students while they are on campus.

Additionally, practice good assessment practices. Assessments and evaluations that are aligned with the pedagogical objectives facilitate by incorporating new learning approaches based on student style of learning. The same applies to academic support as well, providing timely and constructive feedback that enables students are on a positive track with their studies. Abduh & Khan (2023) do research on benefits of online teaching which provided flexibility, improved engagement with technology for students. In the same direction, Martin-Gomez & De Luna (2022) found that the incorporation of information communication technology has a positive effect on performance; this led to affirmations supporting modern technological teaching adaptations can be useful in promoting student outcomes.

Statistical Analysis

In the assessment of academic achievement, the distribution of grades may unveil significant trends. Grades A, D, E, and F, having a mean and standard deviation of zero, may indicate that these grades were not commonly assigned, possibly suggesting a grading system that does not incorporate these categories. Sarkar & Rashid (2016) conducted an extensive examination of the mean and median. Their research was geared towards enriching the comprehension of mean deviation and mean square deviation (standard deviation) from any arbitrary value, encompassing variance. Shown in Figure 3 grades A- and B+ exhibit intriguing characteristics with low averages of 1.8 and 2.4, respectively, along with higher standard deviations of 2.049 and 2.608. This trend implies an irregular bestowal of these grades, indicating a lack of uniformity in their distribution across various academic terms. Figure 3 represents the data from 2020 to 2023, illustrating the relationship between mean and standard deviation.

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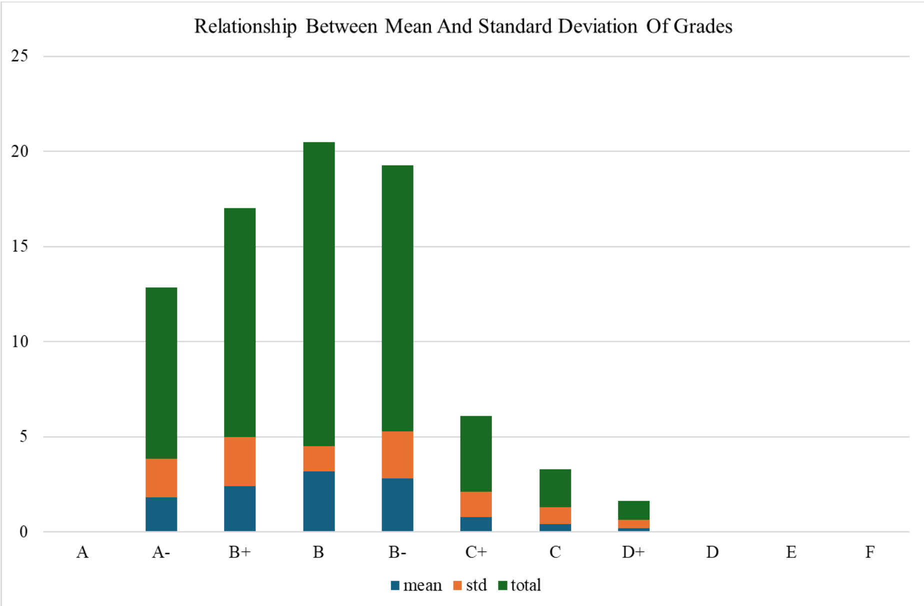

Figure 3: Relationship Between Mean and Standard Deviation of Grades

The grade B stands out for its impressive mean of 3.2, together with a moderate standard deviation of 1.304, indicating a more reliable and consistent method of assigning this grade. This could indicate a central tendency in grading, where a substantial proportion of students obtain scores close to this average, or it could indicate a benchmark for acceptable performance that is often met.

C+ grade, in contrast has an average score of 0.8 These grades also have respectively high levels of standard deviation (2.490 and 1.304). It can therefore be concluded that while there is some inconsistency in their grading, it pales compared to the discrepancies observed elsewhere-most notably in A- and B+ grades. While these grades were proportionally less common than 0-averaging scores, as the standard error indicates either poorly defined quality criteria or more diverse interpretations between individual assessors.

These types of analyses on grading patterns offer a wealth of information regarding the criteria and processes employed for assigning grades in general, leading to better understanding them as well as interpretation and usage within that context. This type of scrutiny might also result in a review of grading standards to prevent bias or maintain the balance and reliability system within academic tests.

Conclusions

The grade distribution is quite straightforward as to how well the students have done based on learning objectives of the course. The performance in early grades were consistently exceptional, indicating that students had a thorough understanding of the theoretical material and practical skills and report writing. Yet the 2023 grade drop indicates that some students may be entering college without mastering essential course content. It is one of the challenges that are related to changes in school curriculum and infrastructure. Improving instruction and widening the range of applicable knowledge can affect future performance as well, while fulfilling course goals.

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