

Factors Associated with Medical Students' Performance in Blueprint-based Online Formative Assessment

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ABSTRACT

Formative assessments had been carried out amidst the changes that have occurred during the COVID-19 pandemic. Medical students must be adapted to change in the teaching and learning process from in-person learning to online learning. This research aimed to determine pre-clinical students' weaknesses in terms of the results of formative assessments based on question blueprints (UTB I) and to find out whether gender, admission pathway, or learning methods can influence the results of formative assessments. A cross-sectional study was performed on the exam results of 711 medical students who undertook UTB I exam. The instrument of this research was secondary data. Gender, admission pathway, and learning methods were analyzed using an independent t-test and One-way ANOVA. The research showed that the median correct answer on UTB I was less than 50%. There was no significant difference in the mean formative assessment score between the male and female groups ($p=0.743$). It was found that at least two groups had significant differences UTB I scores based on admission pathways ($p<0.001$). Based on the learning method, the results indicate significant differences between in-person learning and online learning ($p<0.001$).

Keywords: Formative Assessment, Medical Education, Online Learning.

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1. INTRODUCTION

Formative assessment is a tool used to observe students' learning progress during the learning process. It functions as a feedback mechanism, allowing students to identify their strength and weaknesses. A well-designed formative assessment provides constructive feedback that can help students address their shortcomings and enhance their learning. Consequently, it is essential that formative assessments are meticulously prepared, adhering to a rigorous blueprint that ensures their validity and reliability.[1]

A blueprint is a tool that can be used to develop an assessment programme. This blueprint functions as a map that ensures that all aspects of the curriculum and educational domain are covered within a specified period. [2,3] The assessment blueprint is a critical component in enhancing the validity and constructive alignment of assessments, particularly in the context of high-stakes examinations.[2] The utilization of formative examinations enables students and instructors to identify their deficiencies by meticulously analyzing the question blueprints.

Several factors have been identified as influential in the context of formative examinations. A longitudinal cohort study conducted on 808 students admitted to the University of Jordan found that admission pathways, such as grades obtained during high school and entry routes, could predict the likelihood of GPA and graduation in medical students.[4] A study conducted at GMERS Medical College in Himmatnagar revealed that female students outperformed their male counterparts in both theory and combined formative assessments. This discrepancy in performance may be attributed to the higher attendance rates of female students in theory classes.[5] These findings imply that factors such as admissions pathways and gender may influence formative assessments.

The recent emergence of a novel strain of coronaviruses, officially designated as SARS-CoV-2, has profoundly impacted human health on a global scale. The rapid transmission of the virus necessitates the implementation of preventive measures to halt its spread. In response, governments have enacted protocols such as quarantine, isolation, and social distancing to curtail transmission and mitigate infection. Concurrently, educational institutions have been compelled to transition to online learning modalities, a shift that has profoundly impacted the teaching and learning processes.[6] This adaptation has been particularly salient for medical students, who have had to adjust to this new modality of education.

This study explores the potential impact of the novel Covid-19 pandemic on formative assessment. A study was conducted on dental students at King Saud University to determine the difference in academic performance before and after the pandemic. The study's findings indicate that student grades for all courses were higher prior to the pandemic. This discrepancy can be attributed to the pressure to deliver learning material effectively and students' desire to achieve a minimum score to pass a course. From a psychological standpoint, stress can serve as a catalyst for motivation, particularly in pursuing goals. Consequently, the impact of pandemic-related stress on students' educational outcomes can be positive.[7]

In Indonesia, a significant instrument employed for formative assessment is the regional stage exam, referred to as Uji Tahap Bersama (UTB). This examination is a regional test organized by the Association of Indonesian Medical Education Institutions (AIPKI). The UTB is a test designed to evaluate the competencies of medical students at specific stages of education. It is administered in three phases: UTB I at the conclusion of the fourth semester, UTB II at the conclusion of the seventh semester, and UTB III at the culmination of the professional education level.[8]

UTB I emphasizes assessing students' basic knowledge. The examination comprises 150 multiple-choice questions (MCQs) administered through a computer-based test (CBT). Due to the exigencies posed by the ongoing pandemic, the administration of this examination is being conducted online. The UTB I question blueprint, meticulously prepared by AIPKI, was methodically divided into five categories. The first category comprises questions pertaining to the structure and function at the molecular, cellular, and tissue levels. The second category encompasses questions concerning regulatory coordination, function, and homeostasis between the organ systems. The third category pertains to the pathomechanism of disease. The fourth category was pharmacology. The fifth category encompasses questions concerning basic medical sciences.

This study aimed to ascertain students' deficiencies with regard to the outcomes of formative assessments, as delineated by question blueprints. This study also seeks to ascertain the potential influence of variables such as gender, admission pathway, and learning methods on the outcomes of these assessments.

2. METHOD

This study employed an analytical cross-sectional approach. Purposive sampling was employed as the designated sampling technique. The secondary data utilized in this study were obtained from the UTB I results for the 2021-2022 academic year, encompassing pre-clinical students at the Faculty of Medicine, Universitas Andalas, who satisfied the stipulated inclusion and exclusion criteria. A univariate analysis was conducted to obtain an overview of the student characteristics associated with the percentage of correct answers based on the question blueprint for UTB I 2021-2022 for FK Unand students. The percentage of correct answers is presented as a boxplot. To identify the factors that can influence formative assessment, an independent t-test and one-way ANOVA were conducted on the variables of gender, admission pathway, and learning methods. Statistical significance was set at $p < 0.05$.

The regional stage exam, referred to as Uji Tahap Bersama (UTB), is administered in three stages: UTB I at the conclusion of the fourth semester, UTB II in the seventh semester, and UTB III at the culmination of the professional education level. The data presented in this study were derived from the results of UTB I, which were conducted in February 2021, July 2021, and July 2022. The question blueprint is summarized in the UTB results, which are grouped into five categories. The number of questions tested consists of 150 multiple-choice questions (MCQ) using a computer-based test (CBT).

The admission system at Universitas Andalas comprises the following components: Seleksi Nasional Masuk Perguruan Tinggi Negeri/ National Selection for State Universities Admission (SNMPTN), Seleksi Bersama Masuk Perguruan Tinggi Negeri/ Joint Selection for State Universities Admission (SBMPTN), Selection for academic ability, Collaboration selection, Selection of students with special needs, and International students. In this study, selection based on superior achievement, collaboration selection, international students, and students with special needs were categorized as special admission pathways.

The UTB I exam is administered to students in their fourth semesters. Due to the ongoing global health crisis, the covid-19 pandemic has led to a shift in educational modalities, with students now engaging in online lectures. Therefore, the UTB I, which was held in July 2021, was administered to students enrolled in in-person learning. Conversely, UTB I, held in July 2021 and July 2022, was assessed for students enrolled in online learning.

3. RESULTS AND DISCUSSION (10 PT)

This section explains the results of the research and at the same time provides a total of 711 students who participated in UTB I, and the characteristics and scores of these participants are enumerated in Table 1. Notably, the majority of the participants, specifically seven out of ten, were female. The

preponderance of UTB I participants were students selected through the SBMPTN process. A significant proportion of the participants engaged in the UTB I program through online modalities. To ascertain the factors that influence the results of UTB I, a one-way ANOVA and independent t-test were conducted. The results indicated no statistically significant difference in the mean UTB I score between the male and female groups. However, a statistically significant variation in the mean UTB I score was observed based on the Admissions Pathways and learning methods.

Table 1 Characteristics And Score Of UTB I Participants

*Independent t-test

Factors		n (%)	Mean	SD	p-value
Gender	Male	218 (30.7)	40.0	9.6	0.743*
	Female	493 (69.3)	39.9	8.3	
Admissions Pathways	SNMPTN	217(30.7)	41.4	8.5	< 0.001**
	SBMPTN	291(40.9)	41.5	7.9	
	Academic capabilities	182(25.6)	35.9	8.9	
	Special admission pathways	21(2.8)	35.8	8.2	
Learning methods	in-person learning	239 (33.6)	42.79	9.0	< 0.001*
	Online learning	472 (66.4)	38.38	8.2	

**One Way ANOVA

Table 2 Differences Medical Student Performance Based On Admission Pathways

Admissions Pathways	Mean difference	CI 95%		p-value*
		minimum	maximum	
SNMPTN vs SBMPTN	-0,2	-2,2	1,8	1,000
SNMPTN vs academic capabilities	5,5	3,3	7,7	< 0,001
SNMPTN vs Special admission pathways	5,6	0,5	10,6	0,021
SBMPTN vs academic capabilities	5,7	3,6	7,8	< 0,001
SBMPTN vs special admission pathways	5,8	0,8	10,7	0,014
Academic capabilities vs special admission pathways	0,08	-5,01	5,17	1,000

* Post-hoc multiple comparisons (Bonferroni)

The highest scores were obtained by participants from the SBMPTN, followed by SNMPTN, academic capabilities, and special-admission pathways. However, a notable disparity emerged between SNMPTN scores and academic capabilities and special admission pathways. A notable disparity was also observed between SBMPTN scores, academic capabilities, and special admission pathways (Table 2).

As illustrated in Figure 1, the UTB I results based on the coordination of regulation, function, and homeostasis between organ systems are not normally distributed. The median values for basic hematology items were the highest, whereas those for musculoskeletal items were the lowest. Two outlier values were observed in the musculoskeletal boxplot (88.9), one outlier value was detected in the cardiovascular boxplot (93.3), one outlier value was noted in the respiration boxplot (90.0), 19 outlier values were identified in the reproduction boxplot (100), and one outlier value was observed in the nervous system boxplot (90.0).

As demonstrated in Figure 2, the UTB I results based on the disease pathomechanism were not normally distributed. The analysis revealed that four question items garnered the highest median scores: inflammation, infection, hemodynamic disorders, and prevention from biomedical perspectives. Conversely, items pertaining to the healing process had the lowest median value. The data-set contained 17 outlier values in the trauma boxplot (100), twenty-nine outlier values in the immune response boxplot (100), twenty-one outlier values in the hemodynamic disturbance boxplot (100), and six outlier values in the healing process boxplot (100).

As demonstrated in Figure 5, the UTB I results based on basic medical sciences were not normally distributed. The nutrition question item exhibited the highest median value, while the "other" question item demonstrated the lowest. The physiology boxplot revealed the presence of two outliers with values of 70.83 and one outlier with a value of 71.73. The biochemistry and medical chemistry boxplot revealed a single outlier value of 100. The anatomical pathology boxplot revealed the presence of four outlier values (100). The microbiology boxplot exhibited 19 outlier values (100). The pharmacology boxplot revealed seven outliers with a value of 100 and seven outliers with a value of 0. The "other" boxplot shows 16 outlier values (100).

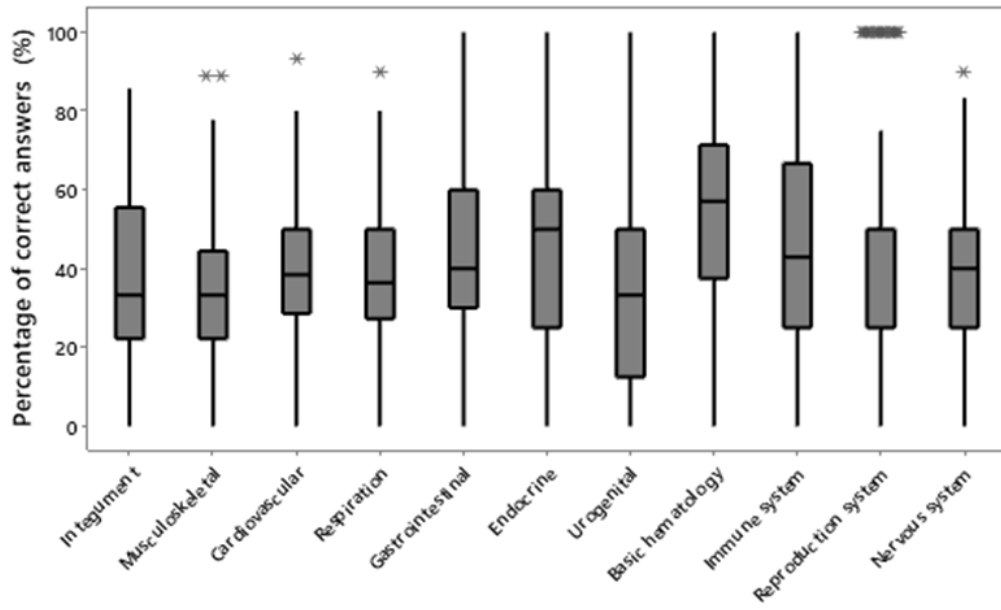


Figure 1. Percentage Of Correct Answers Based On Coordination Of Regulation, Function And Homeostasis Between Organs Or Systems

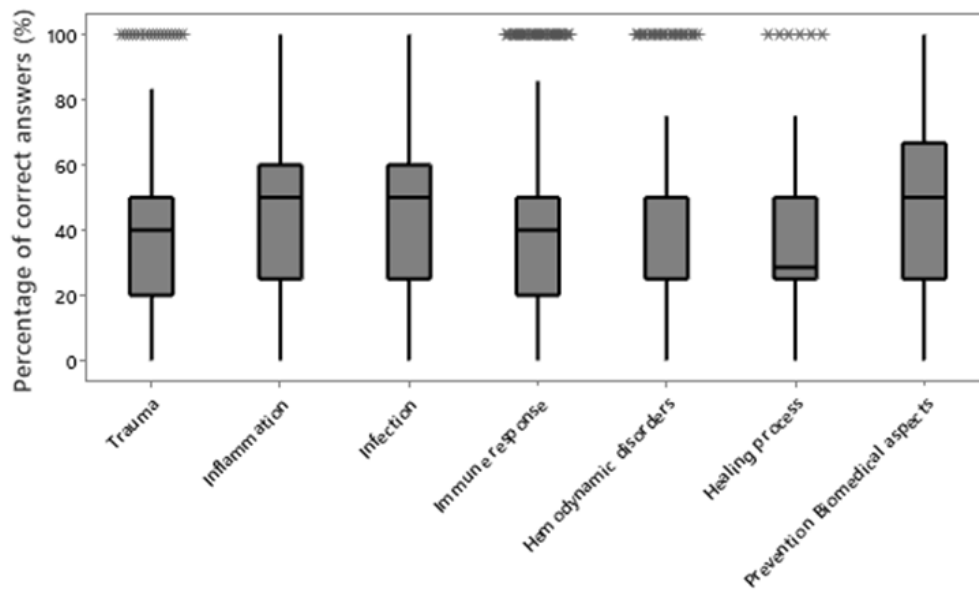


Figure 2. Percentage Of Correct Answers Based On Disease Pathomechanism

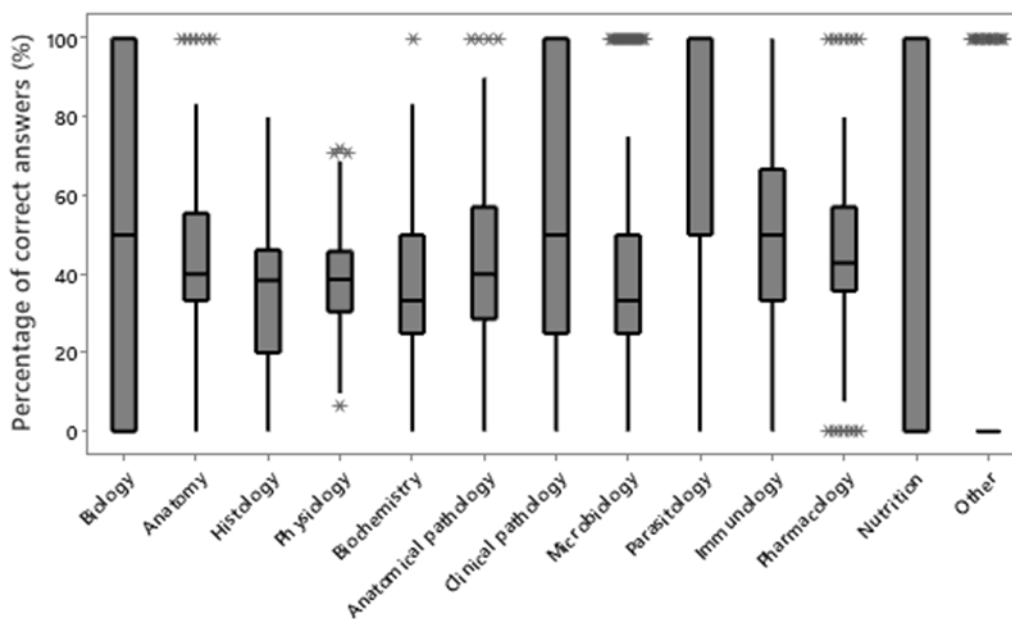


Figure 3. Percentage Of Correct Answers Based On Basic Medical Science

The present study revealed that the male participants obtained higher scores. However, the mean scores for both genders did not differ significantly. Consistent with these findings, a study conducted by the Faculty of Medicine at Sebelas Maret University in Indonesia yielded similar outcomes. The research revealed significant gender-based differences in the progress test.[9]

A statistically significant discrepancy was observed in the formative exam results based on the participants' admission pathways. In this study, participants who took the SBMPTN test obtained the highest scores. Research conducted at the VU University Medical Center examined the relationship between selection and motivation in medical students, revealing that selection can temporarily enhance motivation due to feelings of independence, competence, and inclusion in a distinguished group. Consequently, researchers have hypothesized that the observed variations in formative assessments are attributable to differences in motivation [10]. It is further hypothesized that students who enter through the SBMPTN pathway have the highest formative assessment scores because of their status as selected students and their performance in the written university admission exam, which is known to be the most challenging. A significant difference in the results of formative assessments based on the learning methods has been demonstrated. Historical data indicate that students who engaged in in-person learning prior to the pandemic demonstrated higher levels of academic achievement than their counterparts who pursued online learning. This observation aligns with the research findings of Bettinger et al., who reported a significant decline in student grades, with a reduction of approximately one-third of a standard deviation, among over 230,000 undergraduate students enrolled in online courses.[11] Connolly et al. concluded that the pandemic's global impact has led to substantial changes in the structure of medical education worldwide. The primary challenges reported by medical students and educators include inadequate IT infrastructure, limited contact with patients, a shortage of trained personnel, and mental health burdens.[12] These challenges have led to feelings of frustration among students, who find it difficult to focus on learning. Other research has indicated that medical students may perceive in-person learning as more effective for acquiring practical skills and providing a better learning atmosphere.[13]

The box plot, prepared based on the assessment blueprint, reveals weaknesses in the student population. The presence of a wide interquartile range (IQR) and outliers in the boxplot indicates that students possess a range of abilities, and the research results indicate that students' mastery of the material being tested is suboptimal. The median correct answer for UTB I was less than 50%, suggesting that a significant proportion of students demonstrated insufficient mastery. Knowledge retention significantly influences both low mastery and differences in student ability levels. The material assessed at UTB I emphasizes fundamental scientific principles, yet the material is taught to first-year students, while the test is given to second-year students. This discrepancy may have contributed to the observed decline in performance. Research conducted by Malau-Aduli et al. indicated a marked decline in the retention of fundamental medical sciences knowledge with increasing student seniority, with lower scores attributed to more senior students.[14] Weggemans et al. found that after an interval of 8-10 months, more than half of first-year knowledge could not be reproduced, indicating a significant loss of knowledge over time.[15] Formative assessment feedback can be used to determine students' knowledge retention. Consequently, students and institutions have recognized the significance of formative assessments.

4. CONCLUSION (10 PT)

Formative assessment is defined as an assessment that aims to monitor students' learning progress during the learning process. The provision of feedback on formative assessments enables the identification of students' weaknesses. The findings of the present study indicate that students' mastery of the material assessed was suboptimal. The categories in the question blueprint that exhibited the lowest percentage of correct answers were molecular, musculoskeletal, healing process, and "other."

The investigation further revealed that gender did not impact the formative assessment outcomes. However, it is important to note that admission pathways and learning methods can influence the outcomes of this assessment. These findings underscore the importance of universities developing and implementing policies that consider these factors.

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