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PREDICTIVE VALUE OF PSYCHOMETRIC TESTING IN CONTEXT OF CREATING ADAPTIVE ENVIRONMENT FOR HIGHER MEDICAL EDUCATION

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Summary

The article presents the results of a study aimed at identifying prognostic factors that can predict the long-term success of medical students in higher education. Particular attention is paid to improving methods for selecting applicants and developing supportive activities aimed at increasing students' chances of successfully completing their studies. A cohort study was conducted of 654 students of the specialty “General Medicine” of the Karaganda Medical University, who were admitted to the university in 2019-2021. Upon admission, applicants underwent psychometric testing assessing personality traits, stress, learning strategies and achievement goals. Progressive testing was conducted in 2021 and 2022 to identify the relationship between students' initial characteristics and learning outcomes. A relationship was identified between the level of development of soft skills and academic performance during the first three years of study. Interestingly, we also found the differences in adaptation of students with different psychological characteristics to the transition to online learning during the COVID-19 pandemic. Based on the data obtained, recommendations are proposed for creating an adaptive higher education environment that considers the personal characteristics of students and their initial level of development of soft skills. The article provides valuable practical recommendations for educational institutions seeking to optimize student selection and support processes, as well as create a learning environment that promotes successful learning and student development in medical education.

Key words: *Psychometric testing, soft skills, adaptive learning, medical education.*

Резюме

ПРОГНОСТИЧЕСКАЯ ЦЕННОСТЬ ПСИХОМЕТРИЧЕСКОГО ТЕСТИРОВАНИЯ В КОНТЕКСТЕ СОЗДАНИЯ АДАПТИВНОЙ СРЕДЫ ВЫСШЕГО МЕДИЦИНСКОГО ОБРАЗОВАНИЯ

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Статья представляет результаты исследования, направленного на выявление прогностических факторов, способных предсказать долгосрочный успех студентов-медиков в высшем образовании. Особое внимание уделяется улучшению методов отбора абитуриентов и разработке поддерживающих мероприятий, направленных на повышение шансов студентов на успешное завершение учебы. Проведено когортное исследование 654 студентов специальности «Общая медицина» Медицинского университета Караганды, поступивших в 2019-2021 годах. При поступлении абитуриенты проходили психометрическое тестирование, оценивающее свойства личности, стресс, стратегии обучения и мотивацию. В 2021 и 2022 годах проведено прогрессивное тестирование для выявления связи между начальными характеристиками студентов и результативностью обучения. Выявлена взаимосвязь между уровнем развития гибких навыков и академической успеваемостью в течение первых трех лет обучения. Особый интерес представляет выявленные различия в адаптации студентов с различными психологическими характеристиками к переходу на дистанционное образование во время пандемии COVID-19. На основе полученных данных предложены рекомендации по созданию адаптивной среды высшего образования, учитывающей

личностные характеристики обучающихся и их исходный уровень развития гибких навыков. Статья предоставляет ценные практические рекомендации для учебных заведений, стремящихся оптимизировать процессы отбора и поддержки студентов, а также создать среду обучения, способствующую успешному обучению и развитию личностных качеств студентов в медицинском образовании.

Ключевые слова: психометрическое тестирование, гибкие навыки, адаптивное обучение, медицинское образование.

Түйіндеме

ЖОҒАРЫ МЕДИЦИНАЛЫҚ БІЛІМ БЕРУДІҢ БЕЙІМДЕЛУ ОРТАСЫН ҚҰРУ ЖАҒДАЙЫНДА ПСИХОМЕТРИЯЛЫҚ ТЕСТІЛЕУДІҢ БОЛЖАМДЫҚ МӘНІ

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Мақалада медицина студенттерінің жоғары білім берудегі ұзақ мерзімді жетістіктерін болжай алатын болжамды факторларды анықтауға бағытталған зерттеу нәтижелері келтірілген. Талапкерлерді іріктеу әдістерін жақсартуға және студенттердің оқуын сәтті аяқтау мүмкіндігін арттыруға бағытталған қолдау шараларын әзірлеуге ерекше назар аударылады. 2019-2021 жылдары түскен Қарағанды медицина университетінің «Жалпы медицина» мамандығының 654 студентіне когорттық зерттеу жүргізілді. Қабылдау кезінде үміткерлер тұлғалық қасиеттерді, стрессті, оқу стратегияларын және мотивацияны бағалайтын психометриялық тестілеуден өтті. Оқушылардың бастапқы сипаттамалары мен оқу нәтижелері арасындағы байланысты анықтау үшін 2021 және 2022 жылдары прогрессивті тестілеу жүргізілді. Оқудың алғашқы үш жылындағы икемді дағдыларды дамыту деңгейі мен оқу үлгерімі арасындағы байланыс анықталды. Covid-19 пандемиясы кезінде қашықтықтан білім беруге көшуге әртүрлі психологиялық сипаттамалары бар студенттердің бейімделуіндегі анықталған айырмашылықтар ерекше қызығушылық тудырады. Алынған мәліметтер негізінде білім алушылардың жеке ерекшеліктерін және олардың икемді дағдыларды дамытудың бастапқы деңгейін ескеретін жоғары білімнің бейімделгіш ортасын құру бойынша ұсыныстар ұсынылды. Мақалада студенттерді іріктеу және қолдау процестерін оңтайландыруға, сондай-ақ медициналық білім берудегі студенттердің жеке қасиеттерін табысты оқыту мен дамытуға ықпал ететін оқу ортасын құруға ұмтылатын оқу орындары үшін құнды практикалық ұсыныстар берілген.

Түйінді сөздер: *психометриялық тестілеу, икемді дағдылар, бейімделген оқыту, медициналық білім беру.*

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Introduction

In contemporary higher education, students' academic performance serves as a crucial gauge for the quality of education and the readiness of graduates for their future careers. The intricate interplay of various factors influencing successful learning and the attainment of educational objectives is pivotal for both educational institutions and students alike. Key elements contributing to effective learning and academic achievement encompass students' entry characteristics, with motivation playing a central role. Motivation, a crucial factor, varies among students based on their orientation toward achieving goals or avoiding failures [17]. Achievement goals significantly influence academic success, while failure avoidance goals exhibit no impact on either intrinsic motivation or success. Additionally, students' preferred learning styles, as identified by Kolb's empirical model [12], such as diverging, assimilating, converging, and accommodating, play a pivotal role in their academic

performance. Notably, medical students predominantly favor diverging over converging learning [4], with diverging learning associated with lower scores and reduced effectiveness [9].

The growing importance of soft skills in the contemporary world contributes to successful adaptation to diverse educational situations and requirements, influencing learning success. Soft skills, encompassing self-regulation, planning, organizational abilities, and analytical skills, critically impact student performance [20]. Developing effective study skills becomes integral in overcoming academic challenges and fostering successful learning.

Students' choice of learning methods may not always align with the most effective strategies, as they tend to employ fewer effective skills, such as underlining and rereading, instead of more impactful ones like self-checking and distributed practice [5]. Personality characteristics also significantly correlate with academic achievements, with agreeableness, conscientiousness, and openness playing substantial roles [18]. Self-disciplined and conscientious students with an open mind and natural curiosity tend to adopt more effective learning strategies, enhancing their learning potential.

Stress and anxiety remain primary obstacles affecting student performance, potentially leading to burnout and hindering clinical competence development [23,24]. High levels of anxiety can negatively impact concentration, learning, and coping with educational tasks [16,21]. Neuroticism demonstrates a negative relationship with learning strategies, indicating that heightened anxiety may lead to disengagement from meaningful learning experiences.

Examining the joint influence of multiple factors on academic success proves intriguing, with considerations for stress, motivation, and self-efficacy yielding valuable insights [7]. Models exploring how academic stress predicts motivation, metacognitive strategies, critical thinking, and academic performance showcase complex relationships [22]. Additionally, psychological support from teachers positively predicts academic stress, emphasizing the role of teacher support in managing stress [25].

Studies on academic engagement, psychological capital resources (efficacy, hope, optimism, resilience), and academic performance underscore the positive impact of psychological resources on academic success [13]. The relationship between self-efficacy and academic performance is well-established [11], with factors like learning strategies, emotions, perseverance, and goal orientation acting as mediators. Incorporating measures influencing these factors into the curriculum can contribute to preparing successful specialists and mitigating anxiety, burnout, and dropout rates [14].

While many studies focus on the individual effects of different factors on performance, the origins of these effects remain unclear. Furthermore, academic success is often measured solely by grade point average (GPA), but the complex interactions between various factors and their impact on long-term learning outcomes remain unexplored. It is anticipated that applicants with varying levels of motivation, efficiency of learning strategies and learning styles, soft skills, and anxiety will exhibit diverse academic performance in terms of both immediate assessments and knowledge retention.

Therefore, the objective of the current study was to identify characteristics of students entering university that are critical to their long-term academic performance. The following research questions were formulated:

1. How to predict long-term student success in higher medical education and improve approaches to selecting applicants and supporting students to increase their chances of successful completion of their studies?
2. What should be recommended to create an adaptive environment for higher medical education that considers the personal characteristics of students and the initial level of development of soft skills?

Methods

A cohort study was conducted on 654 students specializing in "General Medicine" at Karaganda Medical University, including 147 students admitted in 2019, 203 in 2020, and 304 in 2021. During admission, all students underwent obligatory electronic psychometric testing with validated instruments measuring personality, perceived stress, utility of learning strategies, and achievement goals (Table 1), measuring 33 quantitative parameters.

GPA served as an indicator of academic performance. However, a high GPA might result from meeting course requirements without aligning to final learning outcomes or persistent efforts for top performance across disciplines. To track individual progress to final learning outcomes we used progressive testing that asks students the same competency-oriented questions across all years of study, starting with 2nd year students. An overall score increases from junior to senior years indicate successful program mastery [1] and acquiring knowledge and skills relevant to future professional activities. Participation in progressive testing was voluntary and was done in 2021 and 2022. Therefore, the study encompassed students admitted in 2019 (3rd and 4th years), those admitted in 2020 (2nd and 3rd years), and those admitted in 2021 (2nd year).

K-means cluster analysis categorized students into empirically selected 4 clusters. Parameters were standardized for a mean of 0 and a standard deviation of 1 across the entire sample, parameters with estimated negative impact (last column in Table 1) were reversed. Means and standard errors of PT scores and GPA in 2021 and 2022 were calculated for each cluster. Comparisons between clusters were done using Student's t-test, with $p < 0.05$ indicating statistical significance. Prior to analysis, Kolmogorov-Smirnov test confirmed the normality of all parameters.

The categorization of students into groups, as identified through cluster analysis, is outlined below, delineated by the respective year of admission: Cluster I - 149 students (26 in 2019, 74 in 2020, 49 in 2021); Cluster II - 141 students (33 in 2019, 34 in 2020, 74 in 2021); Cluster III - 192 students (39 in 2019, 54 in 2020, 99 in 2021); Cluster IV - 172 students (49 in 2019, 41 in 2020, 82 in 2021).

The study received approval from the Bioethics Committee of Karaganda Medical University, ensuring confidentiality and utilizing information solely for scientific purposes. Statistical analysis was done in IBM SPSS Statistics 26.0.

Table 1.

Description of quantitative parameters obtained from the survey results.

Tool	Options	Interpretation	Anticipated impact on training effectiveness (positive or negative)
PSQ – Perceived Stress Questionnaire [8]	PSQ_W	Worries	-
	PSQ_T	Tension	-
	PSQ_J	Lack of Joy	-
	PSQ_D	Demands	-
FPI – Freiburg Personality Inventory [3]	F1	Nervousness	-
	F2	Aggression	-
	F3	Depressivity	-
	F4	Irritability	-
	F5	Sociability	+
	F6	Composure	+
	F7	Dominance	-
	F8	Inhibition	-
	F9	Openness	+
	F10	Extraversion/introversion	+
	F11	Emotional instability	-
	F12	Masculinity/femininity	-
3x2 Achievement Goal Model [6]	Sap	Self-approach	+
	Sav	Self-avoidance	+
	Tap	Task-approach	+
	Tav	Task-avoidance	+
	Oap	Other-approach	+
	Oav	Other-avoidance	+
Learning Styles Inventory [12]	AE	Active Experimentation	+
	RO	Reflective Observation	+
	CE	Concrete Experience	+
	AC	Abstract Conceptualization	+
Study habits survey [5,19]	Strategy1	Deep learners	+
	Strategy2	Lazy deep learners	+
	Strategy3	Busy deep learners	+
	Strategy4	Shuttle-bus learners	-
	Strategy5	Surface learners	-
	Strategy6	MCQ preppers	-
	Strategy7	Laid-back learners	-

Results

The study utilized results from students' obligatory psychometric testing (special exam) during admission. Using cluster analysis, we identified four clusters, each distinguished by varying levels of personal characteristics, stress, learning strategies, and achievement goals among students (Figure 1).

Table 2 presents the descriptive characteristics for each identified cluster.

Across all clusters, the 2022 PT results showed improvement compared to 2021, indicating progress in mastering the educational program regardless of the admission year (Figure 2).

Statistically significant differences were observed between clusters, particularly for students admitted in 2020. For 2021 PT results (2nd year), Cluster I outperformed Cluster II, Cluster III, and Cluster IV ($p=0.004$, $p=0.001$, $p=0.000$, respectively).

Regardless of the cluster, the 2021 PT results of 3rd-year students admitted in 2019 are lower compared to the 2022 PT results of 3rd-year students admitted in 2020. The differences are statistically significant within Cluster I ($p=0.001$), Cluster II ($p=0.021$), Cluster III ($p=0.004$), Cluster IV ($p=0.03$), and across clusters: Cluster II compared to Cluster I and Cluster III ($p=0.000$, $p=0.01$, respectively), Cluster III compared to Cluster I, Cluster II, and Cluster IV ($p=0.000$, $p=0.01$, $p=0.043$, respectively), Cluster IV compared to Cluster I, Cluster II, and Cluster III ($p=0.000$, $p=0.006$, $p=0.002$, respectively). The exception is Cluster I: its 3rd-year students do not have statistically significant differences in 2021 PT results compared to other clusters for 2022 PT results.

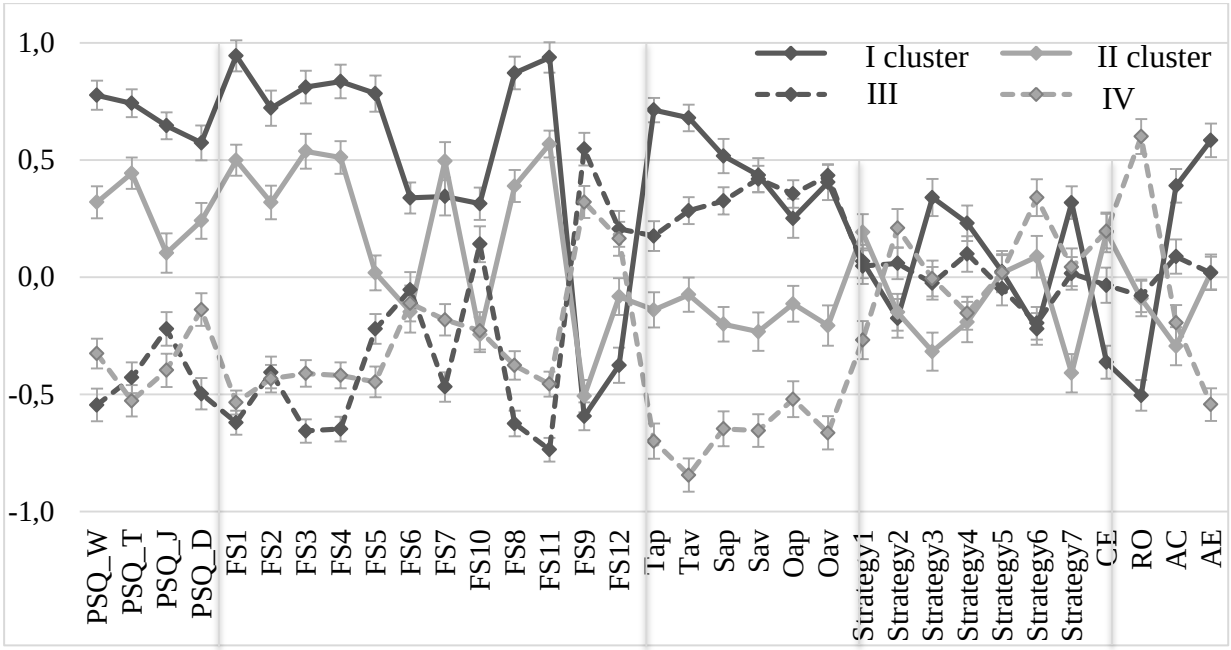


Figure 1. Standardized values of psychometric characteristics of students of NJSC «KMU» who entered in 2019, 2020 and 2021.

Table 2.

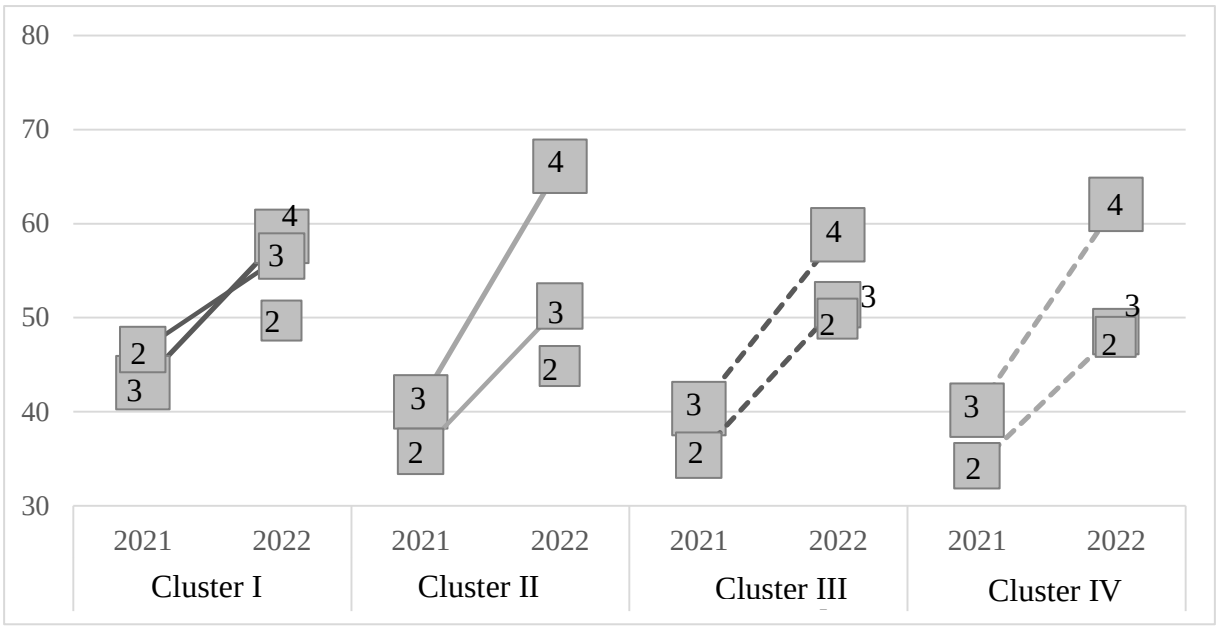
Descriptive characteristics of identified clusters of students.

Clusters	Characteristics	Academic performance
I cluster	- Low stress levels, - No signs of psychological instability, developed sociability, moderate balance and social adaptability, low emotional lability, but at the same time there is some tendency to closeness, aggression, - High motivation, especially in relation to an absolute goal, - Preferred learning strategies: among the effective ones - intensive training while being busy, among the ineffective ones - memorization of test tasks, - Preferences for active experimentation and abstract conceptualization.	GPA is consistently high regardless of the year of admission and course, Overall high result of PT, positive dynamics
II cluster	- Low level of stress, - No signs of psychological instability, sociability and balance are not expressed, a tendency towards introversion and closedness, - Motivation is not expressed, - Preferred learning strategies: among the effective ones - intensive training, among the ineffective ones - training on the way to study and reluctant training, - Preferences for specific experiences.	GPA is high, but not stable, Low start of PT, high dynamics by 4th year
III cluster	- High level of stress, - Signs of psychological instability, a tendency to aggression and emotional lability, but at the same time to extraversion and openness, - Motivation is high, especially in relation to interpersonal goals, - Preferred learning strategies: among the effective - no, among the ineffective - memorization of test tasks, - There is no dominant learning style.	GPA is not stable, depends on the year of admission, Low start of PT, high dynamics by 4th year
IV cluster	- High level of stress, - Signs of psychological instability, a tendency towards introversion and emotional lability, but at the same time openness is developed, - Low motivation, - Preferred learning strategies: among the effective ones – intensive training «half-heartedly», among the ineffective ones – training on the way to study, - Preferences to reflection and observation.	There is a large spread in GPA, depending on the year of admission, Low start of PT, high dynamics by 4th year

The same pattern is observed regarding the PT results of 2nd-year students depending on the year of admission. The 2021 PT results of 2nd-year students admitted in 2020 are lower than the 2022 PT results of 2nd-year students admitted in 2021. The differences are statistically significant within Cluster II, Cluster III, and Cluster IV (p=0.016, p=0.000, p=0.000). Between clusters, the differences are statistically significant in Cluster II compared to Cluster I, Cluster III, and Cluster IV (p=0.001, p=0.000, p=0.001, respectively), in Cluster III compared to Cluster II and

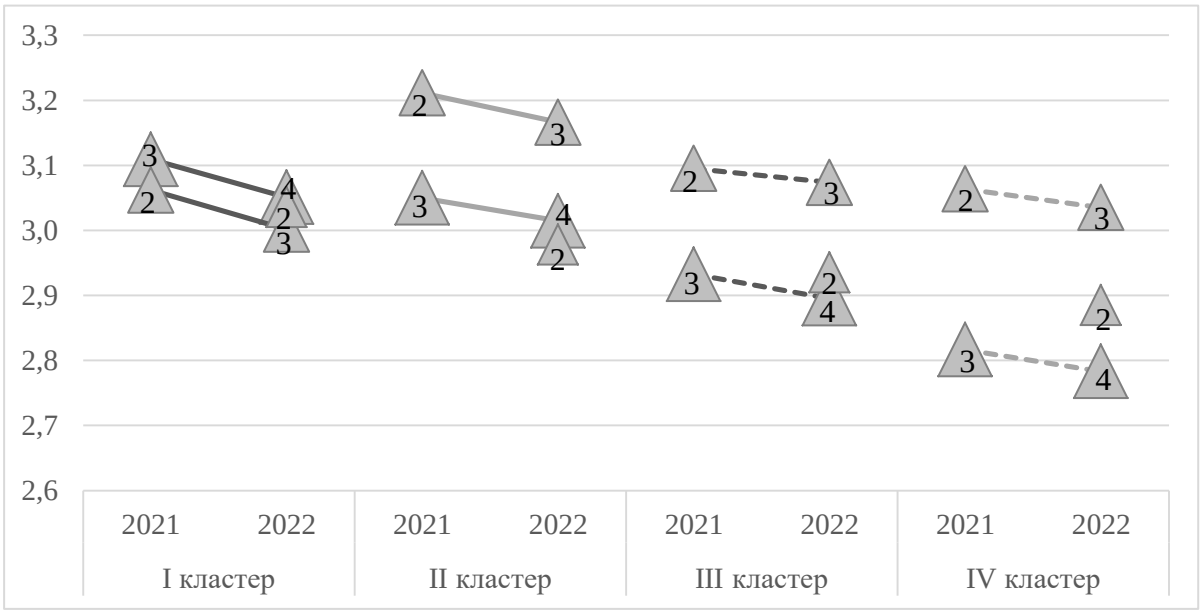
Cluster IV (p=0.003, p=0.000), in Cluster IV compared to Cluster I, Cluster II, and Cluster III (p=0.000, p=0.003, p=0.000, respectively). The PT results by the 4th year do not show significant differences between the clusters.

Analysis of GPA revealed no consistent academic performance dynamics within cluster groups from 2021 to 2022 (Figure 3). However, inter-cluster comparisons exhibited variations. For students admitted in 2019, GPA was gradually reducing from Cluster I to Cluster IV, revealing statistically significant differences between Cluster I and Clusters III, IV for both 2021 (p=0.015, p=0.000, respectively) and 2022 (p=0.032, p=0.000, respectively), and between Clusters II and IV for both 2021 (p=0.000) and 2022 (p=0.000).



Note – The numbers on the graph indicate the students' year of study.

Figure 2. Average values of progressive testing scores in groups identified by cluster analysis.



Note – The numbers on the graph indicate the students' year of study

Figure 3. Average GPA values in groups identified by cluster analysis.

Students admitted in 2020 showed the highest GPA in Cluster II, with significant differences for both 2021 and 2022 compared to Cluster I (p=0.012, p=0.006, respectively) and compared to Cluster IV (p=0.026, p=0.049, respectively).

Students admitted in 2021 exhibited the similar dynamics in GPA between clusters, from the highest values in Cluster I to the lowest values in Cluster IV. Statistically significant variations were identified for 2022 GPA: Cluster I compared to Cluster III and Cluster IV (p=0.045, p=0.004,

respectively), and Cluster II compared to Cluster IV (p=0.043).

Comparisons based on admission year showed that students in Cluster I consistently maintained a high GPA with no significant intra-cluster differences. In other clusters, students admitted in 2020 demonstrated higher academic performance than those admitted in 2019 and 2021. Noteworthy differences were found when comparing GPA within clusters: 2021 GPA of students admitted in 2020 with those admitted in 2019 in Cluster II (p=0.021), Cluster III (p=0.007), Cluster IV (p=0.000), as well as 2022 GPA of students admitted in 2020 with those admitted in 2019 and 2021 in Cluster II (p=0.03, p=0.002, respectively), Cluster III (p=0.003, p=0.004, respectively), and Cluster IV (p=0.000, p=0.006, respectively). The higher GPA of students admitted in 2020, compared to those admitted in 2019 and 2021, persisted in inter-cluster comparisons, also demonstrating statistical significance.

Discussion

Based on the analysis of student performance results by cluster, the most favorable situation with academic performance is observed among students of Cluster I and Cluster II, characterized by resistance to stress and anxiety and relatively successful learning skills. It is characteristic that students of Cluster I, who have the highest motivation among all clusters and the most effective learning style, have stability in academic success and maintaining progress at the proper level. Perhaps due to the initially low motivation to learn, students of Cluster II, based on the PT results, are in a constant mode of "catching up" with the more successful and stable students of Cluster I. However, comparing their situation with students of Clusters III and IV, we can say that the key factor of success is not motivation, but low anxiety and the ability to learn more effectively.

Even though GPA should remain stable, and PT results should grow from course to course, analysis of indicators in the context of clusters characterized by different levels of personal characteristics, stress, productivity of learning strategies and motivational structures of students upon admission showed ambiguous results depending on the year receipts.

It is possible that the low PT results in 2021, indicating that students have not sufficiently mastered the program, are associated with the distance learning format during the pandemic, compared to the PT results of students of similar courses who took a year later against the backdrop of traditional full-time education. The exception is students of Cluster I, whose PT 2021 results are higher compared to other clusters, which suggests that despite the change in learning conditions, students are coping with the program better than students of other clusters. In general, under normal conditions, students make progress in mastering the educational program regardless of their cluster membership.

Students who entered in 2019 demonstrated low PT and GPA results based on the 2021 results, with a deterioration from Cluster II to Cluster IV. In 2022, the results of the program have achieved progress in all clusters, but no positive dynamics are observed in GPA. It is obvious that students' adaptation is unsatisfactory both during distance learning and after the transition to full-time learning. Students' resources were aimed at restoring gaps in mastering the program, but there was not enough effort to fulfill the requirements of the disciplines.

For students admitted in 2020, Clusters II, III and IV have a high GPA, but a low progress in mastering the program based on the results of the PT in the 2nd year. Either students focused their efforts on formally fulfilling the requirements of the disciplines, or there was a decrease in the requirements of teachers due to the difficulties of learning during the pandemic.

The GPA of 2nd-year students of Clusters II, III and IV of 2021 admission is lower than that of 2nd year student's of 2020 admission, but at the same time, the PT results are significantly higher. This paradox can be explained by the fact that before becoming students, they studied remotely during the pandemic in the final year of school, developed the skills to independently master the material, but "were unaccustomed" to contacts with teachers and fulfilling their requirements, and therefore their adaptation to university is hindered. In general, among students of Clusters II, III and IV, the desire to fill gaps in knowledge and achieve the required level of progress by the senior year is accompanied by a decrease in academic performance.

In our study, we delved into the intricate interplay of personal characteristics, soft skills, stress levels, motivation, learning strategies, and learning styles of applicants upon admission, uncovering their profound influence on the subsequent academic success of students. This influence extends beyond conventional grading systems, encompassing the sustained progress students make in mastering the educational program over the long term. These findings underscore the imperative of refining both applicant selection methods, with an emphasis on psychometric testing, and the implementation of adaptive learning systems within universities. Such systems should be meticulously tailored to the individual characteristics of students, facilitating the acquisition of essential soft skills crucial for successful studies and future professional activities.

Our research challenges the prevailing approach adopted by many universities, which relies on calculating the weighted average GPA as an indicator of students' academic achievements. The limitations of this approach become apparent considering our twice-conducted progressive testing involving students from three different admission years. The PT, focused on measuring the achievement of final learning outcomes, revealed that students excelling in professional knowledge may not always be the most academically successful when assessed solely by GPA. The nuanced analysis underscores that performance and progress in the program hinge on a multitude of factors, including the year of entry, student personality characteristics, stress levels, motivation, learning strategies, and learning style. The most consistent success is observed in students characterized by high motivation, effective learning strategies, and moderate stress tolerance and anxiety (Cluster I). This cohort also exhibits a remarkable aptitude for self-directed learning, particularly evident during the pandemic-induced distance learning period in 2020-2021. In contrast, students with less stable psychological characteristics experienced a significant decline in knowledge during distance learning, often compensating through unjustified and excessive use of internal mobilization reserves, inevitably leading to

"emotional burnout."

Overall, our results emphasize the critical need for an individualized approach to learning, especially during transitions between different forms of education, such as distance learning and face-to-face learning. Guided by these findings, further efforts in the educational process should be directed toward individualizing educational support and adapting to the needs of students to ensure their successful learning and development of skills necessary for professional activities [15, 2]. Drawing from our research, we propose several recommendations:

1) The psychometric testing score, measuring the achievement goals, the extent of soft skills development, self-regulation abilities, and stress tolerance, should contribute to the overall admission score. This approach serves a dual purpose. Firstly, it enables a comprehensive evaluation of the cognitive and personal traits of applicants, facilitating the implementation of adaptive learning. Secondly, it ensures a more meticulous selection of candidates prepared for medical university studies.

2) The instructors should adapt their educational content to the level of soft skills development in students and possess a variety of pedagogical techniques, enabling differentiation based on the soft skills of each student (adaptive learning).

3) The proactive stress management should be introduced for students. This will allow students to approach potential academic challenges prepared intellectually and emotionally. In addition, it helps alleviating the effects of already existing stress on learning efficiency.

4) Throughout the educational journey, fostering the determination and perseverance of students to attain their learning objectives is essential. This involves offering social and psychological support to individuals facing challenges in adapting to the educational environment and striving for academic success.

5) To aid students, consider implementing an elective discipline addressing crucial aspects of academic stress, enhancing soft skills, and exploring effective learning methods. For instance, at Karaganda Medical University, an elective discipline "Psychology of personal development and effective learning" helps students gaining insights into stress in educational contexts, exploring factors contributing to soft skills development, understanding their importance for personal and educational efficiency, and learning to alleviate stress effects.

6) In addition to conventional assessment, it is advised to incorporate progressive testing for evaluating students' academic achievements. This testing method enables the early identification of students' knowledge gaps and the underlying reasons. Simultaneously, regular psychometric assessments should be conducted to evaluate the evolution of soft skills, personal and cognitive structures, communication abilities, and stress management skills.

Hence, during this study, we evaluated the initial proficiency of soft skills in applicants to medical universities, established the correlation between this proficiency and academic performance in the initial three years of study, and put forth suggestions for establishing an adaptive higher education environment that considers the individual traits of students and their initial level of soft skills development.

Authors' contribution:

Bukeyeva A.S. - Contributed to the conception and design of the study, played a key role in data acquisition and analysis, drafted significant portions of the manuscript;

Riklefs V.P. - Led the literature review process, providing critical insights, conducted statistical analysis and interpreted key findings, collaborated in the writing and revising of the manuscript;

Umurkulova M.M. - Designed and implemented experiments and surveys, collected and organized data for analysis, contributed to the interpretation of experimental results and writing of recommendations for adaptive learning environment;

Riklefs V.V. - Provided expertise in the field of educational psychology, assisted in the conceptualization of the research design, contributed valuable insights to the discussion and conclusion sections;

Drobchenko Ye.A. - Coordinated the project and ensured smooth communication among team members, reviewed and edited the manuscript for clarity and coherence, formatted tables, figures, list of references.

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