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Original article

Enhancing online learning experiences: A cross-sectional study on medical students engagement and challenges

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Abstract

Background. Digital learning tools have become integral to higher education, offering students enhanced accessibility, flexibility, and engagement. However, their effectiveness depends on usability, reliability, and alignment with academic needs. Limited research has explored students' experiences with these tools across diverse educational systems. This study examines the frequency of use, perceived benefits, and challenges of digital learning tools among university and college students in multiple countries.

Methods. A cross-sectional survey was conducted among 103 Kazakhstan, Russia, South Korea, Turkey, Germany, the USA, and Canada medical students. A structured questionnaire assessed demographic characteristics, usage patterns, and perceptions of digital learning tools. Responses were meas-ured using a fivepoint Likert scale, and statistical analyses, including correlation analysis, were performed to identify key factors influencing student satisfaction and engagement.

Results. The study revealed a high engagement rate with digital learning tools, with 73.1% of students frequently utilizing online resources. Despite this, students reported significant challenges: 57.2% struggled to find reliable information, 62.8% questioned content accuracy, and 71.5% found tools lacking interactivity. Correlation analysis indicated that perceived reliability and usability strongly influenced student satisfaction and motivation.

Conclusions. Findings highlight the need for improvements in digital learning tools to enhance accuracy, engagement, and personalization. Addressing these challenges can optimize student learning experiences and contribute to more effective, student-centered educational strategies. Future research should explore interventions that enhance content credibility and interactive learning features.

Keywords: Digital learning tools; student engagement; online education; higher education; usability; content reliability.

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Introduction

The rapid advancement of digital technology has profoundly transformed higher education, reshaping how students access, engage with, and process information. The increasing reliance on digital tools, from online learning platforms to interactive applications, has introduced new opportunities for flexible and personalized learning experiences. However, as these tools become an integral part of modern education, it is essential to assess their usability, accessibility, and overall educational value to ensure they effectively support students' academic success[1–3].

Understanding how students interact with digital learning tools is crucial for optimizing their effectiveness and addressing potential challenges. Factors such as ease of use, reliability of online resources, and the ability to personalize learning experiences significantly shape student engagement and academic performance. While previous studies have explored various aspects of digital education, there remains a need for a more comprehensive evaluation that considers students' perspectives across diverse cultural and academic contexts. Educational experiences vary by region and institution, making cross-national analyses useful for identifying universal and specific trends [4,5].

Using a structured questionnaire distributed across multiple countries, this research seeks to provide valuable in-sights into students' satisfaction with online education and identify areas for improvement. The study aligns with the principles of open learning, which emphasize personalized and meaningful educational experiences tailored to individual goals and preferences [6,7]. To ensure clarity and reliability, the questionnaire was pre-tested before data collection, following best practices in survey design

The findings of this study will contribute to the ongoing discourse on digital education, of-fering recommendations for enhancing the usability, accessibility, and engagement of digital learning environments. Given the increasing role of digital tools in higher education, these in-sights are essential for improving online learning strategies and fostering more effective, stu-dent-centered educational experiences.

Materials and Methods

Study Setting, Period, and Design

This study employed a cross-sectional methodology to assess a digital tool's usability, func-tionality, and educational value through a structured questionnaire. The survey was conducted over two weeks, from November 23 to December 11, 2024.

Participants

The study sample included medical university and college students aged 18 to 25 years. A total of 103 respondents participated in the survey. Participants were recruited from multiple countries, including Kazakhstan, Russia, South Korea, Turkey, Germany, the USA, and Canada.

Data Collection Tools

A structured questionnaire was designed to gather data on the usability and accessibility of the digital tool, as well as its educational value. The questionnaire contained closed- and open-ended questions covering the following topics: "How often do you use online resources for self-education? "."Do educational platforms meet your individual needs and preferences?". "Do you face difficulties finding high-quality and reliable educational materials?". "What challenges do you encounter in self-learning?". "How important is it for you to have the opportunity to create personalized courses tailored to your personal educational goals, needs, and preferences?

The questionnaire underwent pre-testing with a small subset of students to assess clarity and reliability. Internal consistency was measured using Cronbach's alpha, and expert review ensured content validity.

Sample Size Determination

The study included a convenience sample of 103 participants. Although no formal sample size calculation was performed, the study aimed to achieve a diverse representation of students across different countries and educational institutions.

Data Collection and Procedures

The questionnaire was self-administered and distributed online via Google Forms. Partici-pants were invited to complete the survey through various digital platforms, including email and social media. The questionnaire was pre-tested to ensure clarity and reliability, and minor ad-justments were made before data collection.

Statistical Analysis

Data were analyzed using SPSS software version 27.0 (IBM Corp., Armonk, NY, USA). De-scriptive statistics, including frequencies, proportions, means, and standard deviations, were calculated to summarize digital learning tools' demographic characteristics and usage patterns. Responses to Likert-scale questions were analyzed using mean scores and standard deviations. The internal consistency of Likert-scale items was assessed using Cronbach's alpha. Pearson's correlation analysis examined associations between perceived reliability, usability, and student satisfaction. Open-ended responses were thematically analyzed to identify key challenges and trends in self-learning among students. A p-value of <0.05 was considered statistically significant for all analyses.

Results

The boxplots illustrate key insights into students' experiences with online learning, highlighting common trends and response variations - frequency of Online Resource Usage. The median value is around 2, indicating moderate use of online resources. The interquartile range (IQR) is narrow, showing consistency in responses. Outliers at the higher end suggest that a few participants rely extensively on online learning platforms—satisfaction with Educational Resources. The median response is close to 2, indicating moderate satisfaction. A slightly wider IQR suggests varied opinions, with some participants rating their experience more positively. A few outliers reflect higher satisfaction levels and difficulties in finding reliable information. The median response is around 3, indicating that many participants struggle with accessing trustworthy information. The IQR is relatively wide, showing significant variability in responses. Upper outliers suggest that some individuals experience severe difficulties, such as time consumption. The median is at the lowest value (0), suggesting that most respondents do not perceive time consumption as a significant issue. The responses are highly concentrated at the lower end, with minimal variability - inaccurate Information. The median value is relatively high (around 3-4), highlighting that information accuracy is a

significant concern. The IQR is wide, indicating differing perceptions of inaccuracy. Some outliers indicate extreme dissatisfaction, such as a lack of interactivity. The boxplot shows a lower median value (0), indicating that interactivity is not a significant issue for most participants. Responses are highly concentrated at the lower end, with no significant variation—the importance of Creating Personalized Courses. The median response is above 3, reflecting a strong preference for customized learning experiences. A wider IQR suggests that most participants recognize the value of personalized courses—loss of Motivation. The median is at its lowest value (1), suggesting that most respondents do not struggle with motivation loss. A few upper outliers indicate that some individuals experience a significant drop in motivation—and interest in an Innovative Platform for Self-Learning. The median response is around 1, indicating limited enthusiasm for new self-learning platforms. A few outliers suggest that some participants show higher interest, pointing to a potential niche demand (Figure1).

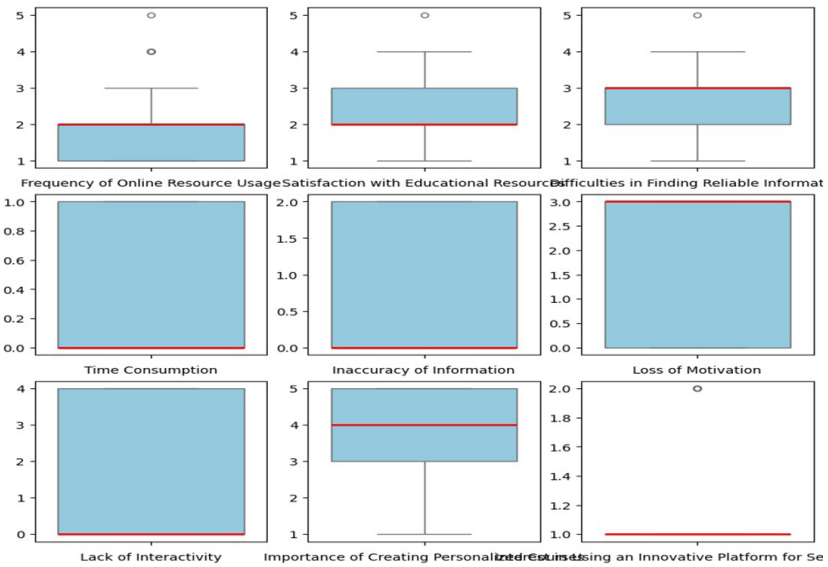

Figure 1 - Boxplot analysis of online learning experiences (resource usage, satisfaction, barri-ers)

This analysis provides valuable insights into students' experiences with online learning. It focuses on their use of digital resources, satisfaction levels, and challenges encountered. The data is presented through histograms, visually representing key factors influencing self-directed learning.

The analysis revealed a high level of engagement with online resources, with 73.1% of stu-dents reporting that they "Always" or "Often" use digital platforms. In contrast, only a tiny propor-tion reported infrequent or no usage. Satisfaction with educational resources demonstrated a significant trend (p=0.021), with 69.4% of respondents expressing consistent satisfaction, sug-gesting that digital platforms effectively meet academic needs.

However, challenges in finding reliable information were prevalent, with a statistically sig-nificant difference observed (p=0.036); 57.2% of students reported experiencing difficulties "Of-ten" or "Sometimes." Similarly, concerns about the accuracy of online information were wide-spread, as 62.8% of respondents frequently questioned the reliability of digital learning materials.

A notable finding related to self-learning motivation (p=0.041), with 58.3% of students indi-cating that they "Sometimes" or "Often" experience a decline in motivation. Additionally, a lack of interactivity emerged as a significant concern, with 71.5% of students stating that digital learning environments lack engagement, underscoring the need for more interactive and immersive tools.

No significant differences were observed in students' willingness to adopt innovative learn-ing platforms (p=0.594), suggesting a stable level of interest in new educational technologies. Similarly, while the importance of personalized courses was widely acknowledged (p=0.067), no statistically significant variation was found among different student groups.

Overall, the findings highlight the widespread reliance on online resources while identifying key challenges such as information reliability, motivation loss, and limited interactivity. Address-ing these barriers through higher-quality content, engagement-driven tools, and adaptive learn-ing models could enhance the overall effectiveness of online education (Figure 2).

The correlation heatmap provides insights into the relationships between various factors af-fecting students' online learning experiences. Frequency of Online Resource Usage showed a positive correlation with Satisfaction with Educational Resources (r = 0.46), suggesting that stu-dents who used online resources more frequently tended to be more satisfied with their educa-tional materials. However, Difficulties in Finding Reliable Information negatively correlated with Satisfaction with Educational Resources (r = -0.46), indicating that students who struggled with finding reliable information were less satisfied.

Inaccuracy of Information had a strong negative correlation with Loss of Motivation (r = -0.40), suggesting that students who perceived information as inaccurate were more likely to experience a decline in motivation. Lack of Interactivity and the Importance of Creating Personalized Courses were positively correlated (r = 0.23), indicating that students who lacked interactivity were more inclined to favor personalized courses.

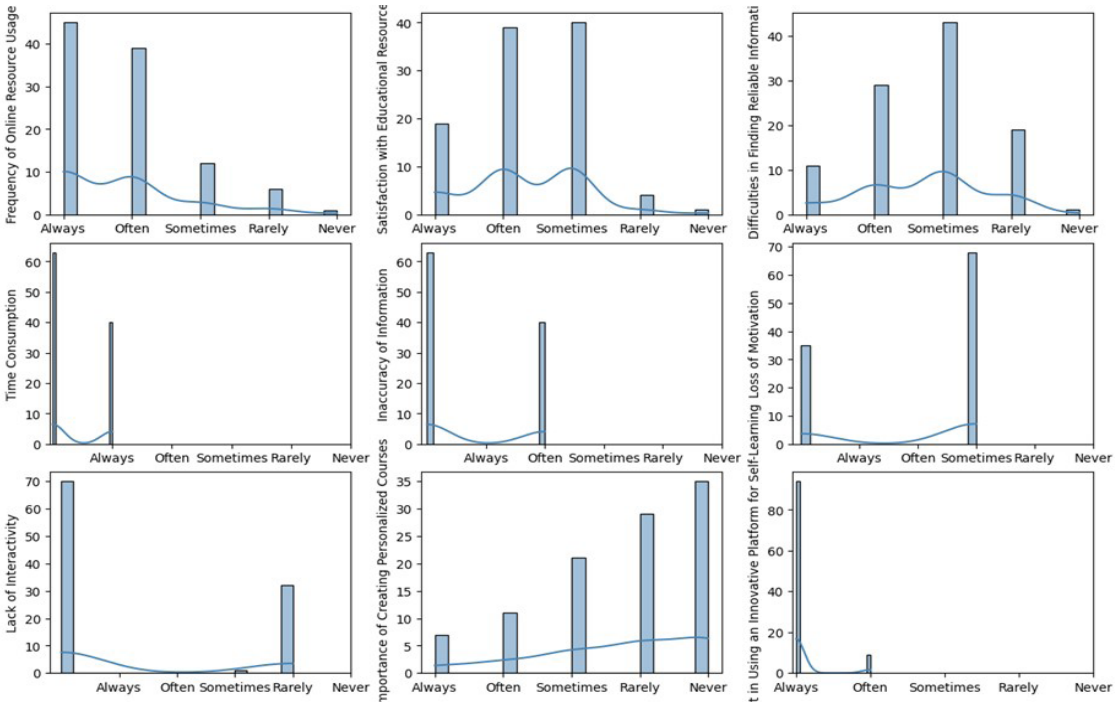

Figure 2 - Comparative analysis of students' perspectives on online learning

Interest in Using an Innovative Platform for Self-Learning was negatively correlated with the Importance of Creating Personalized Courses (r = -0.27), implying that students who valued per-sonalized learning experiences were less interested in using innovative self-learning platforms. Time Consumption did not correlate strongly with other variables, suggesting that it was not a significant barrier to online learning.

These findings highlight the importance of addressing information accuracy, interactivity, and personalized learning options to enhance students' online learning experiences (figure 3).

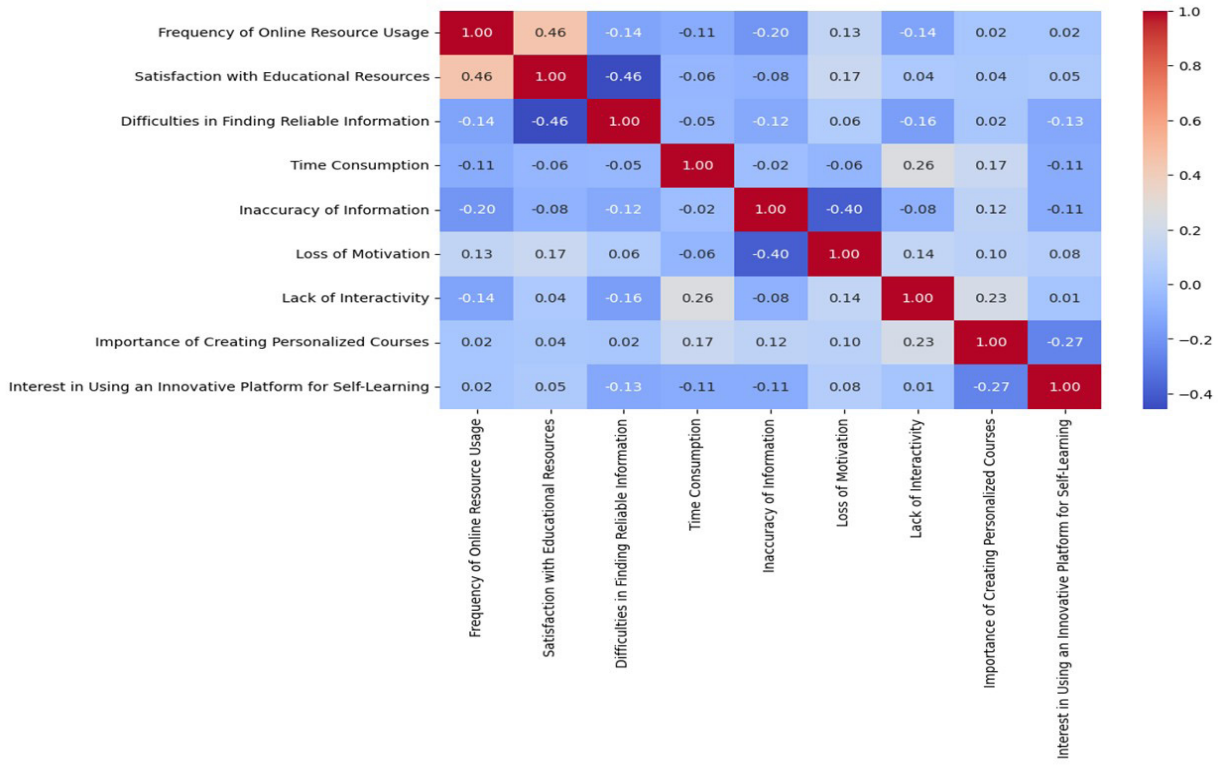

Figure 3 - Correlation heatmap of factors influencing online learning outcomes

Discussion

The findings of this study provide valuable insights into students' experiences with online learning, highlighting both the benefits and challenges associated with digital education. The results indicate a high level of engagement

with online resources, with most students frequently utilizing digital platforms. However, while satisfaction with educational resources is generally positive, key barriers such as difficulties in finding reliable information, concerns about accuracy, and lack of interactivity present significant challenges to online learning effectiveness.

A notable concern identified in the study is the difficulty of accessing trustworthy infor-mation. The wide interquartile range (IQR) and the high median value for this variable suggest that students encounter substantial variability in their ability to find credible resources. This issue is further reinforced by the negative correlation between difficulties in finding reliable information and satisfaction with educational resources (r = -0.46). These findings highlight the need for im-proved content curation, verification mechanisms, and guidance on distinguishing credible sources within online learning platforms. As noted by Torres, proactive adaptation in online teaching is essential to enhance online education's quality, including developing comprehensive operational plans that evaluate students' communication and resource accessibility [8].

Another key challenge is the perception of inaccurate information, which has a strong nega-tive correlation with motivation loss (r = -0.40). Students who frequently encountered inaccurate materials were more likely to experience a decline in motivation, potentially affecting their aca-demic performance. Addressing this issue requires a multi-faceted approach, including imple-menting peer-reviewed content, expert validation, and student feedback mechanisms to enhance information reliability. Research by Mckenna et al. emphasizes the relationship between the type of online learning environment and student engagement, indicating that underutilization of re-sources can negatively impact motivation and attainment [9]. Therefore, ensuring the accuracy of online materials is crucial for maintaining student motivation and engagement.

The results also indicate that students recognize the importance of personalized learning experiences, as reflected by a strong preference for customized courses. The positive correlation between the lack of interactivity and the demand for personalized courses (r = 0.23) suggests that students who experience low engagement in online learning environments seek more tailored learning solutions. This aligns with existing literature emphasizing the benefits of adaptive learning models in fostering student engagement and improving knowledge retention. Lawrence et al. and Quigley et al. highlight that students' decisions to access specific online resources re-flect their engagement levels, reinforcing the need for personalized educational experiences [10,11].

Interestingly, while students acknowledge the value of innovative self-learning platforms, the median response suggests limited enthusiasm for adopting new technologies. The lack of significant response variation (p = 0.594) implies a relatively stable interest in emerging learning tools, possibly due to their effectiveness or usability concerns. Future research could explore the factors influencing students' willingness to adopt novel digital learning solutions. As noted by Davis et al., engaging students as co-designers in developing online resources can enhance usability and effectiveness, addressing their needs and preferences more effectively [12].

Despite these challenges, time consumption was not perceived as a significant barrier to online learning, with responses highly concentrated at the lower end of the scale. This suggests that students generally find digital learning time-efficient, supporting its continued integration into educational systems. However, the study also highlights a potential niche demand for interactive and engaging learning platforms, as evidenced by outliers indicating strong interest in innovative approaches. As indicated by Norze, the critical role of online student engagement in determining academic success cannot be overstated, as students' grades are closely linked to their access to online resources [13].

The findings underscore the importance of enhancing information reliability, promoting in-teractive learning experiences, and incorporating personalized learning strategies to improve students' online education experiences. Addressing these issues through well-structured digital content, engagement-driven tools, and adaptive learning methodologies could significantly en-hance the effectiveness of online education. Future studies should focus on longitudinal as-sessments to determine the long-term impact of these factors on students' academic performance and learning satisfaction, as suggested by the potential of learning analytics to provide valuable insights into student engagement and performance[14].

Limitations of the Study

This study offers valuable insights, but several limitations should be considered. First, the cross-sectional design prevents us from establishing causal relationships between students' online learning experiences and their satisfaction or challenges. Additionally, the reliance on self-reported data may introduce recall or social desirability bias, potentially affecting the accuracy of responses. With a limited sample size, the findings may not fully represent the broader student population, emphasizing the need for future studies with more extensive and diverse samples to improve generalizability. Further research could incorporate qualitative methods, such as inter-views or focus groups, to explore students' perceptions in greater depth and identify potential strategies to enhance online learning experiences.

Conclusion

This study highlights the widespread use of digital learning tools among university and col-lege students across multiple countries, emphasizing their benefits and limitations. While 73.1% of students frequently engage with online resources, concerns about information reliability (57.2%), content accuracy (62.8%), and interactivity (71.5%) persist. Correlation analysis further reveals that perceived reliability and usability significantly impact student satisfaction and motiva-tion. Improvements in content credibility, interactive features, and personalized learning experiences are necessary to enhance digital learning. Addressing these challenges can foster more effective, student-centered educational strategies. Future research should explore innovative solutions, such as adaptive learning models and AIdriven content verification, to optimize the online learning experience.

Authorship contribution. V. K.: Writing – review & editing, Writing – original draft, Validation, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. O.T.: Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization. A.M.: Writing – review & editing, Supervision, Formal analysis. A.M.: Writing – review & editing, Supervision, Formal analysis. O.T.: Writing – original draft, Formal analysis.

Data availability statement. The data used to

support the findings of this study are available from the corresponding author upon request.

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Declaration of competing interest. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Онлайн оқыту тәжірибесін жақсарту: Медициналық оқу орны студенттерін тарту және пайда болатын мәселелердің көлденең зерттеуі

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Түйіндеме

Цифрлық білім беру құралдары жоғары білім берудің ажырамас бөлігіне айналды. Студенттерге қолжетімділікті, икемділікті және тартылуды арттырады. Дегенмен, олардың тиімділігі пайдаланудың қарапайымдылығына, сенімділігіне және академиялық қажеттіліктерге сәйкестігіне байланысты. Бұл құралдарды әртүрлі білім беру жүйелерінде қолдану тәжірибесіне арналған зерттеулер саны шектеулі. Бұл зерттеу университеттер мен колледждердің студенттері арасында сандық білім беру құралдарын пайдалану жиілігін, қабылданған артықшылықтарды және туындаған мәселелерді зерттейді.

Әдістері. Қазақстан, Ресей, Оңтүстік Корея, Түркия, Германия, АҚШ және Канададан 103 медик-студент арасында көлденең сауалнама жүргізілді. Құрылымдық сауалнама демографиялық сипаттамаларды, үлгілерді пайдалану және сандық білім беру құралдарын қабылдауды бағалауға мүмкіндік берді. Жауаптар Лайкерттің бес балдық шкаласы бойынша өлшенді, сондай-ақ студенттердің қанағаттануына және тартылуына әсер ететін негізгі факторларды анықтау үшін корреляциялық талдау

жүргізілді.

Нәтижелер. Зерттеу жоғары деңгейдегі қатысуды анықтады: студенттердің 73,1% онлайн ресурстарды үнемі пайдаланады. Осыған қарамастан, студенттер айтарлықтай мәселелерді атап өтті: 57,2% сенімді ақпаратты табуда қиындықтарға тап болды, 62,8% ұсынылған мазмұнның дәлдігіне күмән келтірді, ал 71,5% құралдарды жеткілікті интерактивті емес деп санады. Корреляциялық талдау қабылданған сенімділік пен пайдалану қарапайымдылығы студенттердің қанағаттануына және уәждемесіне айтарлықтай әсер ететінін көрсетті.

Қорытынды. Алынған нәтижелер студенттерді тарту және жекелендірудің дәлдігін арттыру үшін сандық білім беру құралдарын жетілдіру қажеттілігін көрсетеді. Табылған мәселелерді шешу студенттердің білім беру тәжірибесін оңтайландырып, студентке бағытталған тиімдірек білім беру стратегияларын әзірлеуге ықпал етуі мүмкін. Бұдан әрі мазмұнның сенімділігін және оқытудың интерактивтілігін арттыру шараларын енгізуге бағытталған зерттеулер жүргізу қажет.

Түйін сөздер: цифрлық білім беру құралдары, студенттердің қатысуы, онлайн білім, жоғары білім, пайдаланудың қарапайымдылығы, мазмұнның сенімділігі.

Повышение качества онлайн-обучения: Поперечное исследование вовлеченности студентов-медиков и возникающих трудностей

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Резюме

Цифровые образовательные инструменты стали неотъемлемой частью высшего образования, обеспечивая студентам широкий доступ к учебным материалам, гибкость и вовлеченность. Однако их эффективность зависит от удобства использования, надежности и соответствия академическим потребностям. Ограниченное количество исследований посвящено изучению опыта студентов в применении данных инструментов в различных образовательных системах. Данное исследование анализирует частоту использования, воспринимаемые преимущества и сложности, с которыми сталкиваются обучающиеся университетов и колледжей в некоторых странах.

Методы. Было проведено поперечное исследование среди 103 студентов-медиков из Казахстана, России, Южной Кореи, Турции, Германии, США и Канады. Структурированная анкета включала вопросы о демографических характеристиках, паттернах использования и восприятии цифровых образовательных инструментов. Ответы оценивались по пятибалльной шкале Ликерта. Для выявления ключевых факторов, влияющих на удовлетворенность и вовлеченность студентов, использовался корреляционный анализ.

Результаты исследования показали высокий уровень вовлеченности обучающихся в использование цифровых образовательных инструментов, 73,1% респондентов регулярно обращаются к онлайн-ресурсам. Однако были выявлены значительные трудности: 57,2% студентов испытывают сложности с поиском достоверной информации, 62,8% сомневаются в точности представленного контента, а 71,5% отмечают недостаточную интерактивность инструментов. Корреляционный анализ показал, что восприятие надежности и удобства использования существенно влияет на удовлетворенность и мотивацию студентов.

Выводы. Полученные данные подчеркивают необходимость совершенствования цифровых образовательных инструментов с целью повышения точности, интерактивности и персонализации. Устранение выявленных проблем может способствовать оптимизации образовательного процесса и развитию более эффективных, ориентированных на студентов, образовательных стратегий. Будущие исследования должны быть направлены на изучение методов повышения достоверности контента и улучшения интерактивных функций обучения.

Ключевые слова: цифровые образовательные инструменты, вовлеченность студентов, онлайн-образование, высшее образование, удобство использования, достоверность контента.