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Го Минь

Магистр

Казахский национальный университет им. аль-Фараби

Алматы, Казахстан

РАЗРАБОТКА ОСНОВАННЫХ НА ФАКТИЧЕСКИХ ДАННЫХ МЕТОДОВ РАСПРЕДЕЛЕНИЯ РЕСУРСОВ ОБУЧЕНИЯ СЕСТРИНСКОМУ ДЕЛУ С ИСПОЛЬЗОВАНИЕМ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА И ОБРАЗОВАТЕЛЬНЫХ СТРАТЕГИЙ ДЛЯ ШКОЛЬНИК КОЛЛЕДЖА СЕСТРИНСКОГО ДЕЛА С УЧЕТОМ ГЕНДЕРНЫХ ФАКТОРОВ

Аннотация: Острая потребность в компетентности выпускников сестринского дела в области фактических данных (EBP) имеет первостепенное значение для качества медицинского обслуживания и безопасности пациентов. Целью данного исследования является разработка новой модели с использованием ИИ для оптимизации распределения ресурсов обучения и формулирования образовательных стратегий для студентов старших курсов сестринского дела с учетом гендерных факторов. Предлагаемая модель объединяет теории адаптивного обучения с гибридным ИИ-движком, используя кластеризацию и предиктивную аналитику для создания динамичных, персонализированных учебных траекторий. Используя гендер в качестве корреляционной аналитической переменной, модель направлена на разработку гендерно-чувствительных стратегий для преподавателей, тем самым способствуя более

справедливой и эффективной модели обучения сестринскому делу на основе фактических данных. Результаты включают в себя комплексную концептуальную модель, подробную техническую схему и портфель стратегий вмешательства, которые закладывают основу для будущей эмпирической валидации и внедрения в сестринское образование.

Ключевые слова: Искусственный интеллект в образовании,Сестринское дело, основанное на фактических данных,Распределение ресурсов,Гендерные факторы,Персонализированное обучение,Сестринское образование

GuoMin

Master

Al-Farabi Kazakh National University

Almaty, Kazakhstan

DEVELOPMENT OF AI-ASSISTED EVIDENCE-BASED NURSING LEARNING RESOURCE ALLOCATION AND EDUCATIONAL STRATEGIES FOR SENIOR NURSING STUDENTS CONSIDERING GENDER FACTORS

Abstract: The critical need for Evidence-Based Practice (EBP) competency among graduating nursing students is paramount for healthcare quality and patient safety. This study aims to develop a novel AI-assisted framework to optimize learning resource allocation and formulate educational strategies for senior nursing diploma students, with deliberate consideration of gender factors. The proposed model integrates adaptive learning theories with a hybrid AI engine, utilizing clustering and predictive analytics to create dynamic, personalized learning pathways. By

operationalizing gender as a correlative analytic variable, the framework seeks to generate gender-sensitive strategies for educators, thereby promoting a more equitable and effective EBP education model. The outcomes include a comprehensive conceptual framework, a detailed technical blueprint, and a portfolio of intervention strategies, establishing a foundation for future empirical validation and implementation in nursing education.

Keywords: Artificial Intelligence in Education,Evidence-Based Nursing,Resource Allocation,Gender Factors,Personalized Learning,Nursing Education

Introduction

The imperative for graduating nursing students to achieve proficiency in Evidence-Based Practice (EBP) is unequivocally tied to foundational healthcare outcomes, including enhanced patient safety and elevated quality of care. This competency transcends the mere acquisition of knowledge, demanding the integration of clinical expertise, patient values, and the best available research evidence into complex decision-making processes. Within this context, senior nursing diploma students represent a crucial cohort, poised for immediate entry into a demanding healthcare landscape. Their educational trajectory, however, is fraught with distinct challenges that potentially compromise EBP mastery. These students often enter their final years with markedly heterogeneous foundational knowledge and clinical experiences [1]. This variability is compounded by intensive curricula facing significant time constraints, where the pressing demands of high-stakes clinical preparation can inadvertently marginalize the deep, reflective engagement required for EBP consolidation.

A comprehensive understanding of these educational hurdles must further acknowledge the potential influence of gender as a moderating variable. Emerging scholarship in health sciences education suggests that gender can correlate with differences in learning preferences, communication styles, and self-efficacy perceptions. Furthermore, interactions with educational technology are not gender-neutral; these dynamics can influence engagement and outcomes. Ignoring this dimension risks designing interventions that, while technologically advanced, fail to address the nuanced realities of a diverse student population.

Artificial Intelligence (AI) presents a paradigm shift to address these multifaceted challenges. It offers the capability to move beyond static, one-size-fits-all instructional models towards a dynamic system of hyper-personalization. By intelligently analyzing individual learner data, AI can facilitate the creation of tailored learning pathways and enable the real-time allocation of educational resources. This technological approach does not replace educator expertise but empowers it by providing data-driven insights into each student's evolving learning needs, pinpointing specific EBP competency gaps, and predicting future performance trajectories.

Consequently, this study aims to develop a novel AI-assisted framework specifically designed for optimizing EBP learning resource allocation and formulating targeted educational strategies for senior diploma nursing students, with deliberate consideration of gender factors. The primary objectives are to conceptualize an AI model that synthesizes EBP competency metrics with detailed learner profiles inclusive of gender; to define an algorithmic mechanism for dynamic, needs-based

resource distribution; and to generate a suite of gender-sensitive educational strategies derived from the AI-driven analytics, thereby fostering a more equitable and effective pathway to EBP competence.

Theoretical Framework and Proposed AI Model Architecture

The proposed framework is conceptually anchored in a synthesis of established learning theories and contemporary computational approaches. Its foundation rests upon the principle of adaptive learning, which posits that instructional delivery should be dynamically tailored to individual learner needs. This aligns with Vygotsky's Zone of Proximal Development, wherein the system is designed to identify and target the specific gap between a student's independent capabilities and their potential when provided with appropriate support, or scaffolding. The operational definition of learning objectives is directly mapped to validated models of Evidence-Based Practice Competencies, which delineate the core skills in formulating questions, acquiring evidence, appraising research, applying findings, and assessing outcomes. This theoretical integration ensures the model is pedagogically sound and professionally relevant, moving beyond mere algorithmic prediction to a structured educational intervention.

The architecture of the AI-assisted framework is comprised of three interdependent layers. The foundational Data Input Layer is responsible for the ingestion of multi-dimensional data streams that collectively construct a holistic learner profile. This encompasses not only cognitive assessments, such as pre-test scores on critical EBP steps like literature appraisal, but also behavioral metrics harvested from learning management systems, including engagement times with different resource types and

participation patterns in online discussions [2]. Affective and conative dimensions are captured through validated self-efficacy surveys specific to EBP, while simulated clinical decision-making logs provide a rich source of data on the application of knowledge in near-authentic scenarios. The operationalization of gender within this layer is critical; it is treated not as a binary predictive label but as a sociologically-informed analytic variable that may interact with and modulate other learning dimensions. The system investigates whether correlations exist between gender and preferences for instructional modalities, such as video demonstrations versus textual protocols, or patterns in responsiveness to different types of formative feedback, thereby aiming to uncover nuanced, group-level patterns without resorting to deterministic categorization.

The analytical core of the framework is a Hybrid AI Engine, which processes this multi-faceted data through a sequence of computational modules. The initial Clustering Module employs unsupervised learning algorithms, such as K-means or Gaussian Mixture Models, to perform an exploratory analysis of the student population. This inductive process identifies emergent, data-driven learner profiles or phenotypes, which may cluster along axes of EBP proficiency, behavioral engagement, and potentially, gender-influenced interaction patterns. These profiles provide a typology of learning needs. Subsequently, the Predictive Module utilizes supervised learning techniques, including ensemble methods like Random Forest or Gradient Boosting, which are robust to complex variable interactions. Trained on historical data, these models perform two key functions: they predict an individual student's risk of failing to achieve specific EBP competencies, and they forecast their

likely learning trajectory [3]. The final Recommendation Module synthesizes the outputs from the clustering and predictive modules. It operates on a set of pedagogical logic rules, dynamically mapping the characterized learner profile and forecasted needs to a curated set of learning resources from a pre-classified repository. This ensures that a student identified as struggling with statistical concepts in research articles, for instance, is automatically recommended foundational tutorials and simplified learning objects, thereby closing their individual competency gap through a personalized, theoretically-grounded, and data-informed learning pathway.

Methodology for Framework Development and Validation

The development and validation of the proposed AI-assisted framework will be executed through a multi-stage, methodical study design. This structured approach ensures the model is grounded in pedagogical principles, computationally sound, and ethically attuned to the nuances of the learner population. The methodology progresses from a foundational definition of core elements to the technical construction of the AI engine, culminating in the formulation of actionable, gender-sensitive pedagogical strategies.

The initial stage establishes the conceptual bedrock of the entire system by rigorously defining Evidence-Based Practice (EBP) competencies and constructing a corresponding learning resource taxonomy. A systematic process will be employed to delineate the essential EBP competencies for senior diploma nursing students. This will involve a comprehensive review of international nursing education standards, competency frameworks from accrediting bodies, and a synthesis of relevant literature on EBP skill progression. The objective is to produce a granular,

measurable set of competencies that span the entire EBP process, from formulating a clinical question to integrating research findings into a care plan. Concurrently, a comprehensive Learning Resource Library will be created. This repository will aggregate diverse educational materials, including interactive video demonstrations, graphical abstracts of research papers, simulated patient case studies, and tutorial documents. Each resource will be meticulously tagged using a controlled vocabulary that maps it directly to one or more of the defined EBP competencies. Furthermore, resources will be annotated with metadata describing their instructional modality, cognitive demand level, and estimated completion time [4]. This structured taxonomy is not merely an organizational tool; it is the essential substrate that enables the AI's subsequent precision in resource allocation, ensuring that any recommendation is intrinsically linked to a specific learning objective.

The second stage transitions from pedagogical structuring to computational implementation, focusing on the selection and training of the AI algorithms that constitute the framework's analytical core. The justification for algorithm selection is predicated on the nature of the multi-dimensional data and the specific educational objectives. For the clustering module, unsupervised learning algorithms such as K-means clustering or Gaussian Mixture Models will be prioritized. Their suitability lies in their ability to perform exploratory data analysis, identifying latent patterns and naturally grouping students into distinct profiles based on their EBP proficiency, engagement metrics, and learning behaviors without pre-defined categories. For the predictive module, supervised learning algorithms from the ensemble family, such as Random Forest or Gradient Boosting Machines, are deemed appropriate. These

methods excel at handling heterogeneous data types, capturing complex non-linear relationships between variables, and providing robust predictions regarding a student's risk of developing competency gaps. A rigorous training protocol will be established using a dataset of anonymized historical student records and, if necessary, simulated data engineered to represent a wide spectrum of learner profiles and scenarios. This protocol will involve standard procedures for data preprocessing, feature engineering, and k-fold cross-validation to optimize model hyperparameters, mitigate overfitting, and establish a reliable baseline for the rule sets that govern dynamic resource allocation.

The third and pivotal stage integrates the dimension of gender-sensitivity into the strategy formulation process, moving from descriptive analytics to prescriptive interventions. Following the AI engine's generation of distinct learner profiles, a structured analysis will be conducted to examine correlations between these profiles and gender demographics. This analysis will carefully investigate whether certain learning patterns, resource preference clusters, or predicted risk trajectories demonstrate a statistically significant association with gender. Crucially, this operationalization treats gender as a correlative and interactive variable rather than a causative or binary label. The objective is to identify emergent patterns, for instance, whether a profile characterized by high clinical performance but low self-efficacy and a preference for video-based resources shows a particular gender distribution. Based on these analytical insights, the research will formulate distinct, evidence-informed educational strategies for faculty. These strategies will provide instructors with nuanced guidance tailored to the needs of specific learner clusters. For example, the

system might advise that for a cluster displaying high anxiety and low confidence with a particular gender composition, pedagogical strategies emphasizing structured peer mentorship, low-stakes simulation exercises, and strengths-based feedback are likely to be most effective in boosting engagement and self-efficacy. This final stage ensures that the AI's output is not a black box of data but a translatable tool for fostering a more equitable and responsive educational environment.

Expected Outcomes and Proposed Implementation Strategy

The successful execution of this research is anticipated to yield a suite of deliverables constituting a comprehensive and actionable system for enhancing evidence-based practice education. The primary outcome will be a fully specified conceptual framework that articulates the interrelationships between the core components: the theoretical underpinnings of adaptive learning, the operationalization of EBP competencies, the treatment of gender as an analytical variable, and the computational logic of the AI engine. This framework will be substantiated by a detailed technical blueprint outlining the AI model's architecture. This blueprint will document the data flow from input sources through the processing modules to the final output, specifying data structures, algorithmic interfaces, and integration protocols to ensure reproducibility and future development. A critical deliverable will be a formalized set of dynamic resource allocation rules and decision-making logic. These rules will translate the AI's predictive and clustering outputs into specific, automated actions, defining the conditions under which a student is recommended a particular simulation scenario, a targeted reading, or a foundational tutorial. Finally, the project will produce a portfolio of gender-sensitive educational intervention

strategies. This portfolio will provide faculty with evidence-informed guidance, synthesized from the analysis of AI-generated learner profiles, on how to effectively support distinct student clusters, thereby translating data patterns into practical pedagogy.

The proposed implementation strategy describes a functional workflow for integrating this system into a nursing education environment. The process initiates with a baseline assessment phase where students complete EBP competency diagnostics and self-efficacy surveys, establishing their initial learner profile within the system. As students engage with standard coursework and online modules, the platform continuously harvests behavioral data, enriching these profiles with real-time engagement metrics. The AI engine then processes this aggregated data through its clustering and predictive modules on a scheduled or triggered basis. The output is a dynamically generated, personalized learning plan for each student, accessible through their learning management dashboard. This plan prioritizes resources from the classified library that address their specific predicted competency gaps and align with their identified learning patterns [5]. Concurrently, instructors are provided with a strategic dashboard that visualizes the collective class profile, highlights at-risk students based on predictive flags, and suggests the gender-sensitive intervention strategies from the portfolio. This workflow creates a continuous feedback loop where student interaction with recommended resources generates new data, prompting periodic recalibration of their profile and plan, thus fostering a truly adaptive learning ecosystem.

The validation of the framework's efficacy and equity will be gauged through a multi-

faceted set of proposed evaluation metrics for future empirical testing. Primary key performance indicators will focus on quantitative improvements in EBP competency, measured through standardized assessment scores and rigorous evaluation of clinical decision-making in simulated environments. A significant metric of success will be a measurable reduction in the variation of competency scores across the student cohort, indicating a closing of the achievement gap. Beyond competency, student engagement and perception will be assessed through validated satisfaction surveys and in-depth analysis of learning platform analytics. Crucially, the research will institute specific metrics to evaluate equitable outcomes across gender groups. This involves statistical comparisons of competency improvements, resource engagement rates, and self-efficacy gains between different gender demographics to ensure the system benefits all students effectively and does not inadvertently perpetuate or amplify existing disparities. The ultimate measure of the framework's value will be its demonstrable capacity to elevate overall EBP mastery while simultaneously fostering a more personalized and equitable educational environment.

conclusion

This proposed framework represents a significant departure from conventional educational technologies through its integration of a dynamic AI engine with a nuanced consideration of gender as an analytical variable. Its novelty lies not merely in automating resource allocation but in generating a sophisticated, data-informed understanding of the learner landscape that moves beyond one-size-fits-all digital repositories or standardized instructional methods. By treating gender as a potential correlate of learning patterns rather than a biological determinant, the model

advances a more personalized and equitable approach to nursing education. This conceptual shift acknowledges the complex interplay between sociocultural factors and learning science, aiming to mitigate educational disparities by design rather than by accident.

The implementation of such a system necessitates a rigorous ethical framework. Paramount among these concerns is the safeguarding of student data privacy and security, requiring robust encryption and strict governance policies governing data access and usage. A critical challenge involves mitigating algorithmic bias to prevent the reinforcement of existing gender stereotypes. This will be addressed through careful feature engineering that avoids using gender as a direct input for predictive risk modeling, instead utilizing it in post-hoc analysis to uncover potential inequities in learning patterns or outcomes. Furthermore, the principle of transparency is vital; the logic underlying AI-generated recommendations must be interpretable to educators to foster trust and allow for informed pedagogical intervention, avoiding the "black box" problem that often plagues complex AI systems.

The framework holds substantial theoretical and practical implications. Theoretically, it contributes to learning science by proposing a model for how digital traces and demographic variables can be synthesized to create more adaptive educational environments. Practically, it offers nursing institutions a scalable tool for optimizing educational resource deployment and supporting at-risk students proactively. Acknowledging its limitations is essential; the model's efficacy is contingent on the availability and quality of quantifiable data, and the isolation of pure gender effects remains complex within a multifaceted social learning context. Consequently, future

research must prioritize a pilot implementation study to empirically validate the model's impact on EBP competency development, student engagement, and the promotion of equitable outcomes across diverse student groups, thereby translating this conceptual architecture into a demonstrably effective educational instrument.

References

1. Dorin M., Atkinson H. L. Getting to know AI: Gaps and opportunities for nurse educators // Teaching and Learning in Nursing. – 2024. – Vol. 19. – №. 3. – Pp. 218-224.
2. Nikitara M., Dimalibot M. R., Latzourakis E. et al. Conflict management in nursing: analyzing styles, strategies, and influencing factors: a systematic review // Nursing Reports. – 2024. – Vol. 14. – №. 4. – Pp. 4173-4192.
3. Stavropoulou A., Kelesi M., Baltagianni M. et al. The impact of Continuing Nursing Education on nurses' knowledge and quality of practice: A systematic review // Health Professions Education. – 2025. – Vol. 11. – №. 3. – Pp. 5.
4. Tozsin A., Ucmak H., Soyturk S. et al. The role of artificial intelligence in medical education: a systematic review // Surgical innovation. – 2024. – Vol. 31. – №. 4. – Pp. 415-423.
5. Wong F. M. F. Care Plan Writing in Nursing Education: Challenges, Competence, and Clinical Preparedness // Nursing Reports. – 2025. – Vol. 15. – №. 4. – Pp. 134.