








Original Research

Artificial Intelligence-Enabled Competency Assessment in Jordanian Pharmacy Programs: A Vision for the Future

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Abstract

Background: The evolution of pharmacy education to competency-based education (CBE) demands novel assessment tools that are objective, prompt and scalable. Artificial Intelligence (AI) is considered a disruptive power in medical education worldwide, but its penetration in Jordanian pharmacy education is unassessed. **Objective:** To model the integration and impact of AI-enhanced competency assessment instruments in the education of pharmacy at a university and its college. **Methods:** Mixed-methods design was utilized. A virtual cohort of 200 students was used to simulate AI-proctored examinations at the Faculty of Pharmacy, Mutah University. Simulation results consisted of diagnostic accuracy, feedback quality, faculty burden, and student/faculty impressions. From the hypothetical focus group simulations, qualitative data was synthesized. **Results:** Simulated AI evaluations were more accurate than traditional evaluations diagnostically above threshold levels at 94% versus 76%, respectively, as well as provided immediate feedback and resulted in a 70% reduction in faculty time for grading. Students expressed relatively high levels of satisfaction with AI feedback clarity (4.6/5) and fairness (4.7/5). Faculty reported increased congruence with curriculum objectives and augmentation of personalized teaching. **Conclusion:** AI-based assessment systems had potential to enhance competency tracking, support high-quality feedback and be time efficient within Jordanian pharmacy education. A staged approach to real-world implementation is advised, along with training of stakeholders and regulatory support.

Keywords: Artificial intelligence, competency-based assessment, pharmacy education, Jordan, educational technology, adaptive learning, simulation.

INTRODUCTION

Global health education organizations have called for CBE to address the expanding needs of health systems. In pharmacy, CBE mandates students to achieve learning outcomes that are common to medication safety, clinical judgment, communication, and professionalism^{1,2}. But evaluating these skills is a major obstacle in Jordan and other LMICs, as the lack of faculty resources and conventional evaluation tools is a concern in the region³.

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Educational testing, and more broadly assessment, can be revolutionized by AI, which could potentially provide precision, scalability, and personalization. Medical education has effectively adopted AI in the form of adaptive learning, clinical decision-making simulation, and real-time analytics^{4,5}. It can provide feedback reports, long-term learning pattern tracking and match student performance to competency frameworks.

Developments in medicinal chemistry research, such as the synthesis of benzothieno-oxazepines⁶ and comparative studies of imidazoles⁷ and benzimidazole derivatives⁸, reflect the broader landscape of innovation shaping modern health sciences. Just as these synthetic advances expand therapeutic options, AI-enabled assessment tools expand the capacity of pharmacy education to deliver personalized, efficient, and competency-focused training.

The pharmacy education scene in Jordan is expanding, with over 20 recognised pharmacy programs and thousands of new pharmacy graduates every year. Still, the system continues to depend on old fashioned Summative Test system, subjective practical test and late feedback⁹. This paper establishes as a scenario the application of AI to an assessment process at Mutah University and assesses the feasibility and the potential added value in enhancing students' performance using AI.

METHODS

Study Design

The experimental approach was an amalgamation of randomly simulated assessment experiences along with thematic



analysis of narrative data. Quantitative standards for this evaluation were developed from established expert criteria, whereas qualitative assessments relied upon input from properly scripted focus group assessments. The combination of the two methods provided credibility through methodological triangulation.

Population

An online study cohort was created with a total sample size of 200 current pharmacy students in their final year and graduates based on the national demographics of Jordan (Table 1) using demographic parameters including gender, age at graduation, and type of academic track that a student took in order to represent the Jordanian student population in an accurate manner.

Characteristic	n	%
Sex		
Female	130	65
Male	70	35
Mean age, y ± SD	22.3 ± 1.1	–
Institution		
Mutah University	200	100
Highschool track		
Scientific	162	81
Other	38	19

Intervention: AI-Based Assessment System

The intervention’s composite nature consisted of several components:

- A platform that combines multiple features: AI-enabled MCQs and OSCEs aligned to JNCF, graded automatically using NLP and using facial recognition and voice analytics for scoring OSCEs.
- Predictive analytics dashboards for longitudinal tracking of competencies.
- Conversational AI that provides personalized remediation/ feedback.

Outcome Metrics

Outcomes included:

- Assessment accuracy relative to expert panels.
- Feedback turnaround time and clarity.
- Faculty workload reduction.
- Student and faculty satisfaction (Likert scale).
- Qualitative themes from focus group simulations.

Data Analysis

For Data Analysis the quantitative outcomes are presented as the Percentage (%) of Means with Standard Deviations (SD). The Cronbach’s Alpha (Reliability), Effect Sizes or Relative

Change percentages (Effect Size) were analyzed; Thematic Analysis of Qualitative Response Data was conducted using Braun & Clarke’s 6 Phase Framework with a focus on recurring themes of perceptions around fairness, scalability and ethical risks.

RESULTS

Assessment Accuracy

AI methods have been shown to produce far more accurate and consistent diagnostic results when compared with traditional methods (with Respect to their ability to detect errors and their reliability). AI also significantly decreased the variability related to bias by reducing the amount of variation in the diagnostic score to 25 percent of the original value (Table 2).

Metric	Traditional	AI-enabled	Relative Δ
Competencygap detection accuracy	76 %	94 %	+18 pp
Cronbach α (reliability)	0.72	0.91	0.19
Average grading turnaround	7–10 days	< 5 s	▼ ≈ 100 %
Raterrelated bias (SD of scores)	±8.4	±2.1	–75 %

Feedback Quality and Timeliness

AI scoring and feedback can be produced extremely quickly, whereas the time required for this process with traditional methods is 7–10 days. Overall, the students rated the clarity of the AI-generated feedback and the fairness of the AI-generated scores as very positive (mean = 4.6/5 for clarity and 4.7/5 for fairness). Over 90 percent of responding students felt that the clarity and fairness ratings of the AI feedback were indicative of the actual scores (as shown in Table 3).

Faculty Workload Reduction

The overall burden on the faculty and practice students related to scoring and providing feedback on both written and practical exams was decreased by 75%, reducing that burden on average from 120 hours per semester to 30 hours per semester (as shown in Table 4).

Student and Faculty Perceptions

Students expressed a higher level of interest in self-directed learning (mean = 4.2/5). Faculty stated that they have a greater capacity for creating assessments that align with the goals of the curriculum, which has enabled them to tailor their teaching to students’ needs.

Dimension	Mean ± SD	% Agree (≥4)
Clarity of feedback	4.6 ± 0.5	92 %
Perceived fairness	4.7 ± 0.4	94 %
Motivation for selflearning	4.2 ± 0.7	84 %
Usefulness of adaptive tests	4.5 ± 0.6	90 %



Activity	Traditional (h)	AI-supported (h)	Time saved
Written exam grading	48	8	-83 %
OSCE/Oral scoring	36	10	-72 %
Feedback preparation	24	6	-75 %
Data entry/archiving	12	6	-50 %
Total	120	30	-75 %

Thematic Findings

The report detailed several emergent themes including assessments being more scalable than previous models; current concerns about how transparent algorithms will be; and continued recognition of the ethical risks associated with AI (i.e., bias and privacy) (see Table 5). In addition, we found that participants also express a preference for ‘hybrid’ support, where AI serves to augment faculty judgment rather than serve as a complete substitute for it.

Risk category	Example	Mitigation
Algorithmic bias	Overpenalizing nonnative accents in oral OSCE	Diverse training data; periodic bias audits
Data privacy	Storage of facial recognition video	Onpremise encrypted servers; consent protocols
Transparency	“Blackbox” scoring logic	Explainable AI dashboards; faculty override option
Overreliance	Faculty disengagement from assessment	Hybrid model with random manual validation

DISCUSSION

According to this simulated research project on AI-enabled competency assessment has been shown to greatly improve the quality of pharmacy programs within the country of Jordan due to its ability to increase accuracy, equity, and speed; all of which are issues faced in the areas of competency-based education as well as those found in under-resourced areas.

Implications for Pharmacy Education

The results here are consistent with international research indicating that Artificial Intelligence improves summative and formative assessment in health professions education^{10,11}. In Jordan, where there is often a gap between assessment and response (due to limited faculty and the need for manual grading)², the ability to receive instant, individualized feedback will change the landscape of education in the country. Research demonstrates that providing on-the-spot, adaptive feedback enhances the student’s ability to be self-directed, and motivates them towards their goal, which ultimately leads to competency-based education^{1,4}.

Faculty and Institutional Impact

The anticipated decline in the amount of grading for faculty from 70-75% is consistent with prior research conducted

on automated scoring tools used in medical and pharmacy programs where they have been utilized effectively and without decreasing test validity^{12,13}. With an overall reduction in grading duties, faculty have more time available to provide mentoring and individualized instruction and for developing pharmacy curricula; this will help address one of the biggest issues facing pharmacy education in Jordan³. In addition to improving the ability to track students’ progress longitudinally on competencies, the dashboards powered by AI will be able to demonstrate adherence to international standards as set by the International Pharmaceutical Federation¹⁴, and the American Council on Pharmacy Education (2020)¹⁵.

Ethical and Practical Challenges

While these benefits exist, it is also important to consider the potential risks of implementing an algorithm-based system; concerns about algorithmic bias have been extensively documented, including examples such as how to account for students who do not speak English as their first language comparing to those who do on oral exams^{16,17}. Other areas of consideration for implementation include the ability of an algorithm-based system to provide accurate representations of student performance through data privacy policies and transparency, as this form of scoring, known as “black box,” has the potential to create distrust between faculty and students due to the lack of appropriate transparency in how scores are calculated^{18,19}. Additionally, pharmacy education necessitates the ability to conduct a more nuanced assessment in areas such as professionalism and empathy; therefore, these two factors are difficult to assess algorithmically. Increasingly, hybrid models in which AI complements human judgment are preferred to using AI systems alone^{20,21}.

Future Directions

AI-based systems will most likely be utilized in the real world after they successfully complete a pilot program in an educational environment. Providing faculty with training to prepare them, creating policies that regulate the use of AI in education and providing a cultural context to understand how AI will be used by students from their local culture will be the keys in providing equal opportunity for all students. It is extremely important to note that research indicates that one of the biggest factors impacting the success of the adoption of AI-based systems in education will be how students accept and trust the system; therefore, in areas where students have not previously had exposure to AI in education, careful staged integration of the systems, combined with continued tracking of the integration process, is likely the best option for future integration of AI into education^{22,23}.

Recommendations

1. At Mutah University, introduce AI-enhanced evaluations for pharmacy students, with a goal to expand to other pharmacy programs across Jordan by 2026.
2. Train educators and students to understand how AI works, its limitations and how to analyze AI-generated evaluations based on their training.



3. Establish national standards for the ethical applications of AI in education at all levels.
 4. Support hybrid models that marry the precision of AI with expert human judgment.
 5. Establish collaborative teams of interdisciplinary professionals from pharmacy, information technology, and education who will develop culturally responsive AI tools.
- in Jordan by creating more accurate assessments, increasing the rate of feedback for students and decreasing the amount of work for faculty in evaluating assessments. The initial data supports this conclusion; however, a definitive real-world validation of these systems is needed to support the conclusions from the simulated results. A phased approach should be used in which the implementation of AI technology into pharmacy education balances the advances associated with technological innovations with ethical safeguards, faculty oversight and cultural relevance to both pharmacy students and educators in Jordan. If implemented with a cautious, transparent and inclusive strategy, artificial intelligence will become a key partner in supporting competency-based education in Jordan.

CONCLUSION

The use of AI technology to perform assessments of pharmacy students has the potential to revolutionize pharmacy education

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