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DIGITAL EDUCATIONAL TECHNOLOGIES IN TEACHING INFORMATION TECHNOLOGIES IN MEDICINE

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Abstract: The course Information Technologies in Medicine should prepare students to manage, interpret and communicate information in medically meaningful situations. Digital educational technologies can support this objective when learning activities produce evidence of practical competence. This article develops a course design that connects a learning management system, interactive preparation, data processing exercises, simulated electronic health records and an electronic portfolio. A focused narrative synthesis of seven publications was used to distinguish competency guidance, evidence on digital learning and findings from electronic health record training. The synthesis supports deliberate combinations of online preparation and supervised practice, while identifying limits to transferring results from other settings. The proposed design links information retrieval, data management, electronic documentation, digital communication and information protection to observable student products. A hypothetical appointment dataset illustrates how duplicate records and missing values can alter an indicator and its interpretation. Assessment combines review of the digital product, explanation of the procedure and independent transfer to a new task. The contribution is an explicit connection between course outcomes, digital learning activities and assessment evidence. No original classroom experiment is reported. The proposed model provides a basis for local implementation and evaluation of practical digital competence in undergraduate medical education.

Keywords: information technologies in medicine; digital education; blended learning; medical informatics; digital competence; electronic health records; performance assessment.

Introduction

Information Technologies in Medicine occupies a distinct position in the medical curriculum. Students use digital systems as a means of learning while simultaneously studying how information systems operate in health care. These two functions need to be connected. Completing an online quiz demonstrates participation in digital education, but does not by itself show that a student can identify a duplicate record, evaluate an information source or explain a chart derived from medical data.

The International Medical Informatics Association recommendations distinguish educational needs for users, generalists and specialists in biomedical and health informatics [1]. This distinction is useful for an introductory medical course: future physicians require an informed ability to use and evaluate systems, while specialist software development represents a different level of preparation. DigComp 2.2 provides a complementary vocabulary for digital competence, including information and data

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literacy, communication, content creation, safety and problem solving [2]. Its general framework requires adaptation to the responsibilities and information practices of medicine.

Research on digital education spans varied technologies, learner groups and outcomes. An evidence map by Tudor Car and colleagues emphasizes that educational design must be considered together with context, infrastructure and learner characteristics [3]. A course therefore needs a coherent relationship between the intended skill, the practice activity and the method of assessment. The aim of this article is to propose such a relationship for Information Technologies in Medicine. The central question is how digital educational technologies can help students produce reliable information products and demonstrate the reasoning behind them.

Methods

The article uses a focused narrative synthesis followed by course design. Targeted searches of scholarly publisher pages, bibliographic records and official framework repositories were conducted on 15 October 2026 using combinations of “medical informatics education,” “digital health professions education,” “blended learning,” “electronic health record training” and “digital competence.” Seven publications from 2019 to 2023 were selected purposively for their relevance to course outcomes, teaching methods or assessment. They comprise two competency documents, three research syntheses and two empirical studies [1–7]. This selection is not an exhaustive systematic review.

For each source, the analysis considered the educational setting, type of evidence, measured outcome and limitations relevant to an undergraduate medical informatics course. Recommendations were distinguished from evidence of effectiveness. The synthesis was used to map proposed outcomes to digital activities and assessable products. No participants were recruited and no institutional achievement data were analyzed. The Results section therefore presents a literature-informed teaching design rather than the outcomes of an implemented intervention. The dataset example and scoring criteria are instructional proposals requiring subsequent evaluation.

Results

Evidence supporting a structured digital learning environment

Vallée and colleagues synthesized 56 studies involving 9943 participants and reported an overall advantage for blended learning in knowledge outcomes [4]. However, substantial heterogeneity limits the use of the pooled result as a prediction for a particular course. The finding supports examining a planned combination of online and classroom activities, rather than assuming that adding a digital component will automatically improve learning. Practical information-management skills also require assessment beyond the knowledge outcomes emphasized in that review.

Kononowicz and colleagues reviewed 51 trials of virtual patients. Comparisons with traditional education showed similar knowledge outcomes and an advantage for some skills, but the evidence was heterogeneous and generally of low quality [5]. This supports cautious use of simulated situations for practice. It does not establish that a simulated electronic record, an online case and a real clinical

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information system are educationally interchangeable. The proposed course consequently evaluates specific information tasks within the simulation.

More direct evidence comes from electronic health record (EHR) training. Miller and colleagues studied a brief simulation activity for internal medicine interns and observed differences in navigation patterns compared with a reference group of residents [6]. The comparison was not a randomized trial of an introductory student course. In a small randomized experiment with 15 medical students, Cheng and Senathirajah found a difference in response time between training groups, without a statistically significant difference in diagnostic accuracy [7]. These studies support observing how learners interact with information, while cautioning against equating faster navigation with better clinical judgment.

Course outcomes and digital learning activities

The proposed course organizes practical learning around five domains. Students learn to retrieve and appraise sources, structure and analyze data, work with electronic documentation, communicate information digitally, and protect information during routine tasks. These are course-level adaptations informed by the competency frameworks [1,2], not a claim of formal accreditation. Each domain requires a visible product and a brief explanation of the decisions that produced it. Table 1 provides the alignment used in the proposed design.

Table 1. Alignment of course outcomes with digital practice and assessment

Learning domain	Digital practice	Evidence to assess
Information retrieval	Search a scholarly database and compare two relevant sources.	Search record, source appraisal and a justified selection.
Data management	Clean a teaching dataset in a spreadsheet and create a summary chart.	Documented corrections, reproducible calculation and interpretation.
Electronic documentation	Locate and update specified fields in a training EHR.	Correct record selection, structured entry and change justification.
Digital communication	Prepare a shared report and complete a simulated remote handover.	Clear message, relevant information and traceable contributions.
Information protection	Resolve a scenario involving access rights and file sharing.	Appropriate access decision and explanation of disclosure risks.

Combining preparation with supervised practice

The learning management system (LMS) provides a consistent location for objectives, short demonstrations, practice files and feedback. Before class, students complete a brief preparation activity and submit one difficulty they encountered. Preparation should focus on a limited operation, such as identifying a table key or choosing an appropriate chart. The teacher uses the responses to

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identify where a demonstration or additional explanation is needed. Uploading extensive reading material without a task would not provide the same evidence of preparation.

During the practical session, the teacher demonstrates a small worked example and explains the decisions behind it. Students then solve a related problem in pairs, alternating between operating the software and checking the result. A subsequent individual task changes the dataset or information requirement. This sequence allows collaborative practice while preserving evidence of each student's competence. In a training EHR, for example, the individual task can require finding a specified laboratory result and documenting its date and units, without asking students to make an unsupported clinical decision.

After class, students place the original task, revised product and a short explanation of corrections in an electronic portfolio. Feedback identifies a specific discrepancy between the submitted work and the intended outcome. The student then revises the product and explains why the change was needed. The portfolio is thus proposed as a record of development across tasks. Its assessment should depend on the quality and traceability of the work, rather than the number of uploaded files.

A practical example of data quality and interpretation

Consider a hypothetical teaching file containing 12 appointment entries, including one exact duplicate of an entry with a missing attendance timestamp. After the duplicate is removed, 11 unique appointments remain; nine have a recorded timestamp and two do not. Students preserve the original file, identify the appointment key, document the duplication rule and calculate the completeness of the timestamp field. The correct calculation is $100 \times 9/11$, or approximately 81.8%. Using the original row count as the denominator would incorrectly produce 75.0%.

This example illustrates why the unit of analysis must be established before a percentage is calculated. The denominator represents unique appointments, while the numerator represents those with the specified field recorded. A missing timestamp cannot automatically be classified as nonattendance, because the absence may reflect incomplete documentation. Students therefore label the output as timestamp completeness and state the limitation. These numbers are constructed for instruction and do not describe patients, institutional performance or student achievement.

The task can be extended by linking a patient table to an appointment table through an identifier and explaining why one patient may have several appointments. Students must avoid deleting valid repeated visits merely because a patient identifier occurs more than once. A final chart should display the defined indicator with a clear denominator and label. Assessment can then examine data structure, the correction procedure and interpretation within one coherent task.

Assessment of practical digital competence

Assessment should combine inspection of the digital product with a short explanation and a transfer task. Four proposed criteria are accuracy of the result, reproducibility of the procedure, interpretation in context and responsible handling of information. Each criterion can be scored from 0 to 3: 0 for absent or incorrect performance, 1 for partial performance requiring substantial assistance, 2 for correct performance with a minor omission, and 3 for correct independent performance with a clear justification. Topic-specific examples are needed to make these levels consistent between assessors.

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The resulting 12-point rubric is a proposed formative instrument, not a validated scale. A later task using a new file or interface can test whether students transfer the underlying principles. For example, learners who can calculate a percentage in one spreadsheet should also explain the numerator and denominator in a differently organized dataset. LMS activity records may identify a need for support, but login frequency and time online should not be interpreted as direct measures of competence.

Discussion

The main contribution of the proposed design is the connection between digital course activities and the information practices expected of future physicians. A demonstration introduces a procedure, supervised work exposes errors, and independent performance shows whether the student can apply the principle again. Digital resources make this sequence easier to organize and document, but their presence alone does not establish educational effectiveness. The literature supports evaluating the complete instructional arrangement and its context [3,4].

Implementation should begin with the available infrastructure and students' prior preparation. A short entry task can identify difficulties with file organization, keyboard use, tables and basic calculations. Additional practice should address the observed difficulty without lowering the intended course outcome. Downloadable learning materials and local copies of practice datasets can maintain continuity when internet access is unreliable. Students sharing computers should still complete an individual assessed component. Accessible text, legible diagrams and consistent terminology help students concentrate on the information task.

Teacher preparation is equally important. Instructors need to construct realistic but fictional records, verify expected results and identify errors that reveal misunderstanding. Training scenarios should specify the information required, the permitted operations and the evidence to submit. An EHR exercise should retain essential relationships between identifiers, dates, values and units, even if the interface is simplified. This allows the lesson to focus on transferable information principles rather than memorization of a particular screen layout.

Information protection should be integrated into ordinary activities. Practice files should contain fictional data, and students should explain who needs access to a shared document and why. Copies, exports and revisions should be handled through the course's designated environment. The aim is to make responsible information use part of successful task performance. The course should also distinguish a technically completed operation from a justified action: the ability to export a table does not by itself establish that exporting it is appropriate.

A prospective evaluation could compare this design with conventional practical teaching using the same content and comparable learning time. The primary outcome should be specified in advance as performance on an unfamiliar individual information task. Baseline skills, attendance, device access and teacher support should be recorded. Analysis should account for class-level allocation where applicable, and assessors should use the same rubric without knowing the teaching condition when feasible. Delayed assessment and teacher workload would help establish whether any benefit is retained and practical to maintain.

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The synthesis is limited by purposive source selection and differences between the reviewed settings and the proposed course. Frameworks provide educational direction rather than estimates of effect; simulation studies do not establish improvements in real patient care. The proposed rubric and lesson sequence require piloting. Future research should examine which components improve transfer, which students need additional support and whether implementation remains feasible under different access conditions.

Conclusion

Digital educational technologies can support Information Technologies in Medicine when they connect preparation, supervised information tasks, feedback and independent application. The proposed design links an LMS, data exercises, training EHRs and an electronic portfolio to observable products and explanations. The data-quality example shows how a routine calculation becomes a task in reasoning about records and meaning. Course evaluation should prioritize practical accuracy, reproducibility, interpretation and responsible information use. Local empirical research is needed to determine whether this design improves durable digital competence among medical students.

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