Journal for Technology and Science
Homepage : https://journal.antispublisher.com/index.php/IPTEKS/index
Email : admin@antispublisher.com

e-ISSN : 3047-4337
JOTECH, Vol. 3, No. 4, October 2026
Page 132-151

Computer Science Education in Medicine: A Student-Based Curriculum Gap Analysis

Yousif A. Saadoon[1*], and Riam H. Saffar[2]
[1] College of Medicine, University of Misan, Maysan, Amarah, Iraq
[2] Ministry of Education, Maysan Directorate, Maysan, Amarah, Iraq

Check for updates OPEN ACCESS

DOI : : https://doi.org/10.61796/ipteks.v3i4.559

Sections Info

Article history:
Submitted: June 23, 2026
Final Revised: July 11, 2026
Accepted: August 16, 2026
Published: September 01, 2026

Keywords:
Medical informatics education
Digital health competencies
Computer science curriculum
Programming education
Artificial intelligence in medicine

ABSTRACT

Objective: *Despite the increasing reliance of clinical practice on electronic health records, picture archiving systems, and AI-powered diagnostics, many medical universities in Iraq continue to emphasize generic digital literacy – how to operate an OS, basic word processing, spreadsheets, and slides – in their computer science courses. One such course is the course of Computer Science that was offered to the 1st stage students at Medicine College, Misan University, Iraq and is discussed in detail in this paper.* ***Method***: *The present study examined the official 2025-2026 syllabus for the course and the existing theoretical and practical teaching content of the course, as well as conducting a survey of 201 students of the first and second year and comparing the results with the literature on digital-health competencies. The design is a descriptive, single-institution case study; the comparative statistics reported below are treated as exploratory rather than confirmatory.* ***Results***: *The 2025–2026 syllabus was determined to be partially updated: it makes explicit reference to Word, Excel, PowerPoint as theoretical concepts, and includes a unit on MEDLINE/PubMed, but excludes a number of actively taught, medically framed units, most notably programming, data analysis and hands-on AI use, and there is no formal or informal chapter on programming, data analysis or hands-on AI work. The students gave the lowest ratings on the ability to distinguish between good and bad performers, with the percentage of agreement for this item being 24.4% (mean 2.67/5), while the highest rating was received for support for curriculum modernization (mean 4.48/5, 87.7% agreement), with AI in medicine being the most required addition (48.3%)* ***Novelty***: *Guided by this research, this paper suggests a 6-domain proposed consisting of foundational digital literacy, computational thinking (CT) and introductory programming, informatics of medical and systems of health data, AI in medicine, medical instuments and real-time systems, and capstone project applied, which can be implemented in the course credit hours, and as a template, be adopted by other medical schools in a similar position. It is an evidence-informed adaptation of existing digital-health competency models rather than a new taxonomy, and remains an untested proposal pending multi-institutional or longitudinal evaluation.*

INTRODUCTION

Background and Rationale

Over the last few years, the healthcare sector has experienced a fast digital transformation. What counts as a digitally literate doctor has moved a long way from where it stood even a decade ago, Driven by electronic health records, picture archiving systems, clinical decision support, remote monitoring and now AI-powered diagnosis. The ability to operate a computer is no longer enough; a graduate today should be able to perform critical interaction with intelligent systems that in some way or another are involved in clinical reasoning. Three terms recur throughout this paper and are used here in a fixed sense to avoid ambiguity. "Computer science" denotes the name and disciplinary home of the course under review, as it is titled in the university curriculum. "Digital literacy" denotes the generic, largely software-operational skill base – operating systems, word processing, spreadsheets, presentation software, basic internet use – that the current course still mostly teaches. "Digital-health competence" denotes the medically contextualized layer built on top of that base: medical informatics, health data systems, AI in medicine, and related clinical applications of computing. The gap this paper documents is, in short, the distance between the second term and the third.

Digital-Health Competency Frameworks

Structured competency frameworks have been developed by international organisations to catch up with this change. Since 2000, recommendations for biomedical and health informatics education have been developed by the International Medical Informatics Association (IMIA) that have been updated in 2010 [1] and 2023 [2] to differentiate the needs of biomedical and health informatics users from those of medical informatics specialists at various stages of their career. On more solid empirical foundations, a more recent Delphi consensus with 211 experts and 79 countries has led to Establishment of the Competencies of Digital Health in Medical Education (DECODE) framework, which outlines digital-health competencies in 4 domains and 19 competencies to aid in curriculum design on a global scale [3].

Structured frameworks matter in practice: in Singapore, medical students and educators identified concrete curricular gaps only once they had such a framework to check their national curriculum against [4], which suggests that gaps of this kind can be difficult to see from the inside without a comparable benchmark. A wider assessment of the barriers to adoption of digital health services comes to a similar conclusion: it is not only infrastructure gaps that present a challenge to the adoption of digital transformation in care delivery, but competency gaps as well [5].

A scoping review of tools employed in measuring digital competence found that none of these fully encompass the complexity of the construct [6]; longitudinal survey data from Finland revealed that medical students' self-assessment of their digital-health competencies can change significantly as the country's health-information infrastructure develops [7]; and a framework for "digital determinants of health" was proposed, suggesting a focus on structural, access-related considerations in addition to skills training [8].

The framework proposed later in this paper draws on this literature but does not attempt to reproduce it. IMIA and DECODE were developed through international, multi-country consensus processes and are pitched at the level of national or cross-national curricula; the six domains proposed here are, by contrast, a single-institution adaptation, built specifically to fit within an existing four-credit course and a nationally standardized Iraqi medical curriculum. The domains of foundational digital literacy, medical informatics, and AI in medicine are recognisably drawn from DECODE and IMIA and are not claimed as new; what is original to this paper is the phased, credit-neutral implementation model (Table 6 and Table 7), and the inclusion of a medical-devices/real-time-systems domain and an applied capstone domain, both of which responded directly to gaps identified in the local curriculum-document analysis and the student survey rather than to the international frameworks themselves.

Artificial Intelligence (AI) in Undergraduate Medical Education

The use of AI in undergraduate medical education has increased rapidly since the release of the first large language model (LLM) in 2022. Over 3200 publications were reviewed, and 310 were chosen for inclusion in a 2025 scoping review, of which more than half had been published in the past eight months leading up to the end of the review – a crude but telling indicator of how quickly this literature is expanding [9]. In South Korea, three sets of medical-AI competencies were developed using a Delphi study, preceded by scoping research mapping the initial introduction of AI content into undergraduate curricula [10], [11].

A separate scope review of AI curriculum frameworks concludes that undergraduate curricula should remain focused on general AI literacy, with more advanced technical training left to postgraduate programs, and that collaboration among educators, data scientists and curriculum designers is needed to develop them [12]. A recent national survey conducted by the Association of American Medical Colleges found that AI is now being included into medical education, with the most frequent mentions related to ethics and general conceptual knowledge rather than technical skills [13].

In the Gulf region, cross-sectional surveys found high levels of awareness of AI and a stated desire for formal curricular inclusion rather than the informal, student-led inclusion that appears to be taking place at present [14]. A comparable survey of 224 students of medical in the Kurdistan area /Iraq reported broad self-reported use of AI tools alongside considerable uncertainty about what AI actually is, with roughly half of respondents unable to define it clearly even as most reported using it informally, again pointing to informal, student-driven adoption running ahead of any formal curricular response [29].

Computational Thinking (CT) and Programming Anxiety

One recurring argument in the literature is that programming itself is not the goal of teaching medical and health-science students to program. What is being built is closer to what is called by some authors "medical CT": recognizing to be able to determine when a CT is the right approach to a clinical problem, and when it is or is not worth it for clinical decision making.

In a study that involved 495 medical-field students, structural equation A positive attitude toward learning to program was found to predict more positive computational-thinking perspectives and greater sense of programming empowerment based on modeling results [15]. An independent factor-analysis research study on 394 health-science students in Saudi Arabia proved that students in medicine and health informatics expressed a significantly better attitude toward CT compared with other health science students, indicating that there might be more interest in this sort of material than is commonly thought [16]. Meanwhile, a systematic review of "programming anxiety" reveals that novices are commonly anxious about code, and that a supportive environment accompanied by carefully scaffolded pedagogy, rather than simply simplifying the technical content, is what aids novices [17]. Apparently, these are useful with a visual and notebook-based tool. In the field of university education, a visual-programming AI course has been shown to lower the learning barrier for students outside of computing-related majors [18]; an interdisciplinary creative-coding approach, using visual and physical-computing tools, has had the effect of developing coding confidence among biomedical science students, who frequently report that they are afraid of quantitative work [19]; and notebook-based, open-source, Python-based courses have been able to teach data-science skills to students with no previous coding experience [20].

Context-Based Learning and Delivery

This relates to an older concept in the literature of education, context-based and situated learning: those technical skills are better remembered, and more readily transferred to actual practice when taught within the context where they will be used, as opposed to being taught as generic tasks outside of that context. Whether it's a spreadsheet exercise based on invoice data, or a slideshow on a generic business topic, a future practitioner is likely to transfer a skill taught in the same manner to the clinical setting, rather than the same skill taught with simulated patient data or a case presentation.

However, on the delivery side, and not the content side, active-learning methods all lead in the same direction. In medical education, flipped classroom reviews are associated with improved student preparation, increased student engagement, and improved critical thinking skills, when the technology is reasonably supported, workload on the instructors is reasonable, and students have appropriate levels of self-directed learning [21], [22].

Evidence Gaps in Resource-Constrained Settings

An important point here is that a significant portion of this literature is generated by high income health systems with relatively advanced technologic capabilities. Evidence for low- and middle-income settings is less available, but evidence-based practice and diagnostics under resource constraints applies equally well to these settings as anywhere else, as does the case for digital and AI-literacy.

In such environments, medical schools are also required to meet competency requirements tailored to well-equipped schools within a limited number of hours to teach, a lack of lab facilities and a faculty with limited training in computing or clinical medicine but not in both. The analysis of a curriculum arising from one such context therefore contains a richness that the literature otherwise tends to be dominated by examples of high income contexts, such that it can be used to test what parts of the international contexts can be transferred without any modification and can highlight the type of barriers that a consensus document written at the international level will never going to be capture. Empirical work from Iraq and the wider Middle East specifically remains scarce. The two regional data points available – the Saudi survey by Almehmadi et al. [14] and the Kurdistan-region survey by Hawezy et al [29] cited above – both point in the same direction as this paper’s findings: strong informal, student-driven engagement with digital and AI tools running well ahead of any formal curricular response. This scarcity of regional evidence, and the consistency of what little exists, is itself part of the motivation for the present case study.

In addition to the medicine theme, there's a broader information-technology-education theme here: how should a computing curriculum be designed to ensure it actually transfers to the profession it is supposed to serve, rather than abstractly teaching computing skills? This is not an issue that is exclusive to medical schools. The same tension that exists in any generic digital-literacy or “introduction to computing” course, where the students who will eventually use the technology have no resemblance to a computer-science major – business students, education students, allied-health students, etc.

The medical-education literature surveyed above is replete with pedagogical responses that are general principles of the discipline-embedded IT education and not specifically related to healthcare. The case study is therefore not just an analysis of the curriculum of one medical school, but it also provides a relatively easy way, by cross-reading an official syllabus and the current teaching materials versus an institution's assessment data, for IT educators in other parts of the world to test whether their own allegedly generic computing course has been able to hold up with the discipline it is supposed to serve.

Research Gap and Objectives

In spite of all the work that has already been done, there is comparatively little evidence documented, in an evidence-based way, of what individual medical schools with real resource constraints are doing to bridge the gap between generic digital literacy and closer to digital-health competence. In this paper, an attempt is made to fill at least part of this gap by studying the 1st stage of the Computer Science course at the Medicine College, Misan University, Iraq. (1) to describe, as clearly as the course's own records, syllabus, and lectures could be interpreted, what the course is actually doing, in this context; (2) to compare this structure with the competency domains that have been identified in recent literature; (3) to determine whether existing assessment practices in the course do in fact discriminate between different levels of competency, as the institution's records, syllabus, and lectures were able to indicate; and (4) to propose a revised structure, designed for phased and resource-realistic adoption, that other medical schools in a similar situation might consider. The overall logic relating these steps is summarized in Figure 1: the current curriculum and literature are read into a gap analysis, which in turn informs the six domain framework (Section 5) and the outcomes that this framework is meant to deliver to.

Figure 1. Conceptual framework connecting the present curriculum, literature, gap analysis, the proposed framework of 6 domains and the outcomes.

Research Method

Research Design

The present case study is descriptive; it consists of a qualitative document analysis of curriculum documents and a cross-sectional student survey in one institution. The analysis of the curriculum document was carried out exclusively based on existing institutional documents which were reviewed by the course teacher (the author) and the survey data was obtained through additional data collection from the students in this study. Because the design is descriptive rather than hypothesis-testing, no formal a priori hypotheses were specified; the Welch's t-test comparisons reported in the Results section are exploratory, intended to describe whether first- and second-stage students perceive the course differently, rather than to test a predefined directional prediction. The implicit research question guiding this comparison was: do first- and second-stage students differ in how they rate the course's current content, relevance, and assessment, and in how strongly they support modernization?

Research Location

This course is a four-credit Computer Science course taught to 1st stage students at Medicine College, Misan University, Iraq. It extends throughout one academic year, and weekly lectures are held in theory, while the labs are conducted in small groups. The student survey described below was administered more broadly, to both first-stage students currently taking the course and second-stage students who had completed it the previous year, so that current and retrospective perceptions of the same course could be compared.

Data Collection Technique

This analysis was based on two types of data. The first is the official 2025–2026 course syllabus [26], which governs the course; the current versions of all the theoretical background material for the course 2025–2026 [27]: fundamental computer-science lectures (information technology fundamentals, history and development of computers, operating systems, internet technologies, data communication, biomedical literature retrieval (via MEDLINE/PubMed)); the practical-laboratory guides for hands-on sessions with Windows and Office-application; software (Word, Excel, PowerPoint).

Second source is a purpose-made student survey [28] that was given to the medical students for 1st and 2nd year at the same college. The questionnaire was distributed electronically as an online survey link to first- and second-stage medical students. Participation was voluntary, and students were given a defined period in which to respond; all completed responses received during that period were included in the analysis, and no student was required to participate. Because inclusion depended on students voluntarily responding to the distributed link rather than on probability-based selection from an enrollment list, the resulting sample is best characterized as a voluntary-response convenience sample rather than a randomized sample. It included 25 items using a five-point Likert scale (1 = strongly disagree, 5 = agree strongly), organized into 5-subscales: prior digital experience before the course (5 items), perceived usefulness of the content of the current course (6 items), perceived relevance of the examples and tasks of the course to the medical field (2 items), perceived ability of the practical exam to differentiate between skill levels (1 item), and perceived required for modernization of the course (11 items covering informatics of medical, records of electronic health, analysis of medical data, introduction to programming, and AI responsible used). Items were developed by the authors with reference to the competency domains identified in the literature review and the structure of the current syllabus. The instrument was administered to students in Arabic, its original language of development, in its final form without a separate expert-validation or pilot-testing phase; this is acknowledged as a methodological limitation below. Table A gives one representative item from each subscale, translated into English for this manuscript. A separate multiple-selection list of topics was then provided and students were asked what they would like to see added to the course. A total of 201 responses (101 in the first stage and 100 in the second stage) were considered valid for the final sample.

Table A. Representative survey items, one per subscale, translated from the original Arabic-language instrument (item code from the source questionnaire shown in parentheses).

Subscale	Representative item (5-point Likert, 1 = strongly disagree to 5 = strongly agree)
Prior digital experience (Q1)	"I had basic skills in using the Windows operating system before entering medical school."
Perceived usefulness of current course (Q6)	"The computer science course helped me improve my basic digital skills."
Relevance to the medical field (Q11)	"The examples used in the lectures were sufficiently related to the medical field."
Practical exam's ability to discriminate skill (Q14)	"The practical exam was able to measure real differences in students' skills."
Need for curriculum modernization (Q20)	"Medical students need to understand how to use artificial intelligence responsibly."

The complete 25-item instrument is not reproduced in full as a public appendix. It remains an internal instructional-assessment tool held jointly by the authors and the course administration at the College of Medicine, University of Misan, and its release outside the institution is subject to the college's own data-governance procedures. Representative items for each subscale are given in Table A above, and the complete instrument, together with the underlying anonymized response data, can be made available to the editor or to reviewers for verification purposes under a confidentiality arrangement, on reasonable request and subject to institutional approval.

The other material (2025–2026) has slightly more recent original authorship dates than some of the basic-concepts lectures and guides (2015–2018), and is also judged for currency as well as content. In this course offering, all were identified as being used (active), either through theory or practice.

Data Analysis Technique

Literature was reviewed to develop a set of competency domains that were then read against the curriculum documents and coded according to whether they were absent, partially present, or substantively present. A domain was counted as being "substantively present" if it appeared as a dedicated, assessed unit of the syllabus; "partially present" if it appeared only descriptively presented in a lecture, but not in a hands-on task or a graded item; and “absent” if it was not found in any of the assessed units of the syllabus or in any of the lectures. For each subscale, descriptive summary statistics (mean, standard deviation, percent of respondents who answered 4 or 5 on the 5-point scale) were computed with Python (pandas and the built-in statistics module).

Cronbach's alpha was calculated for the largest subscale (required for curriculum modernization, 11 items) and the alpha coefficient was $\alpha = 0.94$, reflecting strong internal consistency for this subscale; the other subscales were too brief (1 - 6 items) to be assessed on alpha alone. For each subscale, the first and second grade students were also compared with each other using an independent-samples t-test for unequal variances (Welch's t test), and Cohen's d was calculated if a difference was found to be significant. The initial curriculum-document coding was conducted by the course instructor and subsequently reviewed together with the co-author. No formal independent double-coding procedure was performed and no inter-rater reliability statistic (e.g., Cohen’s kappa) was calculated; coding decisions were anchored to the predefined classification criteria above and cross-checked against the primary curriculum documents rather than made from memory. This is acknowledged explicitly as a limitation below.

Ethical Considerations

Verbal institutional permission to review the curriculum materials and to administer the survey was obtained through the Department and College administration prior to data collection. There were no students identified in any of the information reported about the curriculum, it was not developed by the student, and the analysis used pre-existing institutional resources reviewed by the course instructor. The survey was anonymous, students' identities were not collected, participation was voluntary, and there were no consequences for the students who chose to withdraw or not participate at any stage during the survey. Throughout the survey results are expressed in the aggregate; none of the results can be identified in this paper.

RESULTS AND DISCUSSION

Structural Profile of the Current Curriculum

The organisation of the official syllabus for 2025–2026 is set out in Table 1. It clearly shows that it assumes no prior computing knowledge. The theoretical side now has 9 chapters, divided into 2 parts: 6 chapters of fundamental computer-science content, then 3 more chapters of theoretical lessons on Word, PowerPoint and Excel. The practical side is made up of 24 hands-on chapter-long lab sessions across 2 semesters, first Windows, then Word, then Excel, then PowerPoint. None of the four textbooks given for reference mention health or clinical applications.

Table 1. Official Course Syllabus 2025–2026 – Structural profile.

Component	Content
Stated course objectives	Utilize a computer for basic uses, describe parts of a computer, create word processing documents and presentations, research on the internet.
Theoretical part 1: basic concepts of CS, 6 chapters	Computer basics; computer hardware and number systems; computer software; computer safety; computer software licensing; the internet and communication; MEDLINE.
Theory Part 2: Office Application Theory (3 chapters)	Ms Word, PowerPoint, and Excel (all 2010 version): interfaces, functions, and features
Practical part, semester 1	Windows 10 Introduction (6 sessions); Ms Word (6 sessions)
Practical part, semester 2	Ms Excel (6 sessions); Ms PowerPoint (6 sessions)
Prerequisite knowledge	None; No programming or computer-science background needed
Textbooks of reference	4 Arabic language books of Computer Fundamentals and Office Apps (2011/2014) - not medical focused
Weighting of assessment	Quiz/Attendance = 10%, Mid-Term theory = 20%, Mid-Term practical = 10%, Final theory = 40%, Final practical = 20%.

Medical Contextualization Beyond the Syllabus

The topics covered in the lectures are far more expansive than outlined in the new syllabus. Several of the fundamental-concepts lectures are an example of the teacher's attempt to re-contextualize common and generic computer-science content in the medical field, very different from what the simple chapter titles in the syllabus might suggest. The lecture about the history of computers will introduce the early computers as the direct ancestors of what is used today for diagnostics: ultrasound, CT, MRI, ECG, lab analyzers, electronic medical records. Biomedical literature databases, provider-to-provider communication, e-learning platforms and safe patient data sharing are among the topics covered in a second, more well-rounded internet lecture, parallel to a shorter and more generic lecture of the same plain title as the syllabus, titled “Applications in Medicine and Healthcare”. Hospital information systems and picture archiving systems are the basis for a whole lecture on computer-based medical systems and artificial intelligence in diagnosis, which is not in the syllabus. A dedicated chapter in MEDLINE/PubMed unit teaches truly functional, clinically relevant skills, such as understanding the structure of databases, Boolean concepts, and Medical Subject Headings (MeSH), and well beyond the title of the chapter being “MEDLINE.” These skills are clearly useful for evidence-based practice.

Gap Analysis—Literature Derived Competency Domains

For each competency domain, which is listed in Table 2 and was drawn from the literature, an official syllabus competency is checked against the lecture contentassigns of 2025–2026. These eight domains were selected by combining the core domains named in IMIA and DECODE with two additions – medical devices/real-time systems and an applied capstone – that emerged from a first read of the local teaching materials and were then checked against the survey's multi-select topic list (Table 5) for face validity; this selection process is inevitably interpretive rather than the product of a formal consensus exercise, and is revisited as a limitation in the Conclusion. Both layers lack entirely the domain of CT/introductory programming and the applied capstone task domain. Four others are only lightly mentioned in the newer lecture notes, typically as descriptive or illustrative rather than hands-on. Only the domain of foundational digital literacy is present in a substantively way throughout, and only biomedical literature search has come to a genuinely functional clinically relevant state.

Table 2. Gap analysis refers to the comparison of the competency domains that were identified from the literature with the existing curriculum.

Domain of Competency	Official Syllabus Status	Delivered Material Status
Foundational digital literacy	Substantively present	Substantively present
CT / introductory programming	Absent	Absent
Medical informatics & health data systems (HIS, PACS, EHR)	Absent	present as partial
Biomedical literature search (MEDLINE/PubMed)	Named as a chapter, no detail	present as substantive
AI in medicine	Absent	present as partial (descriptive only)
Medical instrument & real-time systems	Absent	present as partial (illustrative only)
Data privacy, security & AI ethics	Absent	present as minimal
Applied / capstone integration task	Absent	Absent

A similar picture emerges from well-resourced contexts that are undergoing comparable change. In Singapore, medical students and teachers reviewed the national curriculum with a framework for digital competency, and only identified specific concrete gaps because they had that framework to refer to, rather than an overall feeling of a lack of something. [4] What is worth noting in this regard is that the existence or non-existence of a competency domain is not necessarily apparent to the teachers of a course, unless some kind of structured benchmarking process is implemented – such as the one undertaken in this paper. The picture is similar in the United States and Canada, as indicated by national survey data: where AI content has been introduced into undergraduate medical education, it has not been well integrated, nor has it been taught as a credit-weighted, consistent body of knowledge [13] (a close match with the "partially present, descriptive only" designation recorded in Table 2).

Student views on the current curriculum

The survey offers a second line of evidence beyond the above curriculum-document gap analyzes from 201 surveyed students: 101 first-stage students in the current year, and 100 second-stage students who had completed the course a year ago. Descriptive statistics are presented in Table 3 for the five subscales.

Table 3. Descriptive data from the five subscales of the survey (n = 201).

Subscale	Items	Mean (/5)	SD	Agreement
Prior digital experience (pre-course)	5	4.21	0.39	82.4%
Perceived usefulness of the current course	6	3.71	0.38	65.2%
Relevance to the medical field	2	3.02	0.82	36.8%
Practical exam's ability to discriminate skill	1	2.67	1.15	24.4%
Need for curriculum modernization	11	4.48	0.60	87.7%

Students reported to arriving with relatively high prior digital experience (mean 4.21/5, 82.4% agreement; above discussed) in line with the fact that basic literacy in using office-software is become more prevalent among incoming cohorts. The scores were significantly lower on the two item that especially inquired if the lecture examples and practical tasks helped to make the material relevant to medicine (mean 3.02/5, 36.8% agreement) – which was the same as the difference in scores found between the seven medically contextualized lectures and four still-generic Office practical tasks in the document analysis.

The lowest score of all five subscales was for the single question regarding the ability of the practical exam to identify strong and weak students (mean 2.67/5, only 24.4% agreement). Students were merely asked from personal experience of taking the test whether it discriminated by level, and most claimed that it didn't. This is offered here as a plausible reading of the result rather than an established explanation: it seems a reasonable pattern given the content of the exam – a review based on working with a simple operating system and common applications since students' incoming digital literacy (Subscale 1 above) might have been reasonably high, and students seem to have felt this in the exam.

A comparison of first and second stage students.

Each subscale then was compared between the 1st and 2nd stages of the curriculum using a Welch's independent-samples t-test, which does not require equal variances, to compare the two cohorts at different stages in the curriculum (101 at 1st stage and 100 at 2nd stage students). Table 4 shows the results.

Table 4. Welch's t-test was used to compare subscale scores on the survey between first and second stage students (* $p < .05$).

Subscale	Stage 1 Mean (SD)	Stage 2 Mean (SD)	t	p
Prior digital experience	4.21 (0.38)	4.21 (0.41)	0.11	.916
Perceived usefulness of current course	3.79 (0.38)	3.64 (0.36)	2.90	.004*
Relevance to the medical field	3.11 (0.83)	2.92 (0.79)	1.60	.111
Practical exam's ability to discriminate skill	2.75 (1.14)	2.59 (1.14)	1.01	.316
Need for curriculum modernization	4.54 (0.56)	4.42 (0.62)	1.42	.157

For 4 of the 5 subscales, no significant statistically variance between the stages was found: prior digital experience, relevance to the medical field, discriminatory power of the practical exam, and support for curriculum modernization all trended in broadly similar directions across the two cohorts (Table 4). The only statistically significant difference was in perceived usefulness of present course content, rated higher by 1st stage students than by 2nd stage students (3.79 vs. 3.64, $t = 2.90$, $p = .004$, Cohen's $d = 0.41$, a small-to-moderate effect). One plausible reading, offered here as an interpretation rather than a demonstrated cause, is that first-stage students, being recent and active users of Word, Excel and PowerPoint, may value the course's current content more directly, while second-stage students, who have had more exposure to clinical training, may be more aware of what the course does not yet cover; the cross-sectional design cannot confirm this and a longitudinal follow-up of the same cohort would be needed to test it directly. Read alongside the generally modest ratings for medical relevance and assessment quality across both stages, this pattern is at least consistent with the concerns raised throughout this paper not being confined to, or resolved within, the first stage of study.

The most significant outcome of the survey, by a wide margin, was support for modernizing the course (mean 4.48/5, 87.7% agreement, $\alpha = 0.94$ across the 11 items). Students were then asked in a follow-up multi-select item which topics were most important to them; the top responses are shown in Table 5.

Table 5. topics that students want to prioritise were identified as their most wanted topics (multi-select; n = 201).

Topic students want prioritized	% selecting it
AI in medicine	48.3%
MEDLINE/PubMed literature search	39.3%
informatics of medical	37.8%
records of the electronic health	34.8%
Medical data analysis	34.3%
Medical instrument and real-time systems	27.4%
Simplified programming	26.4%
Data privacy and security	24.9%

This ranking is very similar to the 6-domain framework suggested in Section 5. The single highest use of AI as requested was in medicine (48.3%), the second, MEDLINE/PubMed, (39.3%) already making up a substantial part of the course, while medical informatics (37.8%) and ehealth records (34.8%) and the analysis of data (34.3%) were requested. The proposed low-level role of Programming in the framework, with scaffolding, was represented by lower, but still significant (26.4%) score, compared to a regular Programming course. By contrast, the three already widely-used Office spreadsheets were the least requested items (Excel 16.4%, Word 9.0%, PowerPoint 1.5%), which again confirmed that these are dominating the course time allocation around documents.

Proposed Six-Domain Framework

The review of the literature identified four design principles that influenced the following design. First, content needs to be reframed in the context of clinical context, which already exists structures in the lectures of 2025-2026 but is also present in the practical and assessment layers. Second, and following from the results of the source literature reviewed, there is a low anxiety, scaffolded path from the visual and/or block useage tools to notebook-based Python coding for any programming component. Third, AI content should focus more on critical appraisal and ethical literacy rather than technical implementation, as per the survey results of undergraduate AI curricula in general [13]. Fourth, the current assessment also did not differentiate for skills because of the design of the current practical examination: they state that the current practical examination does not differentiate for skills in integrated tasks for skills that require students to integrate skills instead of demonstrate skills separately.

Table 6 outlines some suggested adjustments in the weighting of courses across six domains of an adapted version of a course domain structure (as described, for example, in the DECODE course frameworks [3]). The same re-distribution is displayed graphically in figure 2.

Table 6. An alternative distribution of course time and weighting by domain, relative to the current estimated allocation.

Domain	Current Curriculum (estimated)	Proposed Framework
Foundational digital literacy (OS, Office)	≈70%	15%
CT & introductory programming	0%	20%
informatics of medical & systems of health data	≈20%	20%
AI in medicine	≈5%	20%
Medical instrument & real-time systems	≈5%	15%
Applied / capstone project	0%	10%

The "current curriculum (estimated)" column in Table 6 is the author's approximate allocation of course time based on the syllabus structure and the number of theoretical and practical sessions devoted to each area (Tables 1 and 2); it is not derived from a formally logged instructional-hours audit, and should be read as an informed estimate rather than a measured figure.

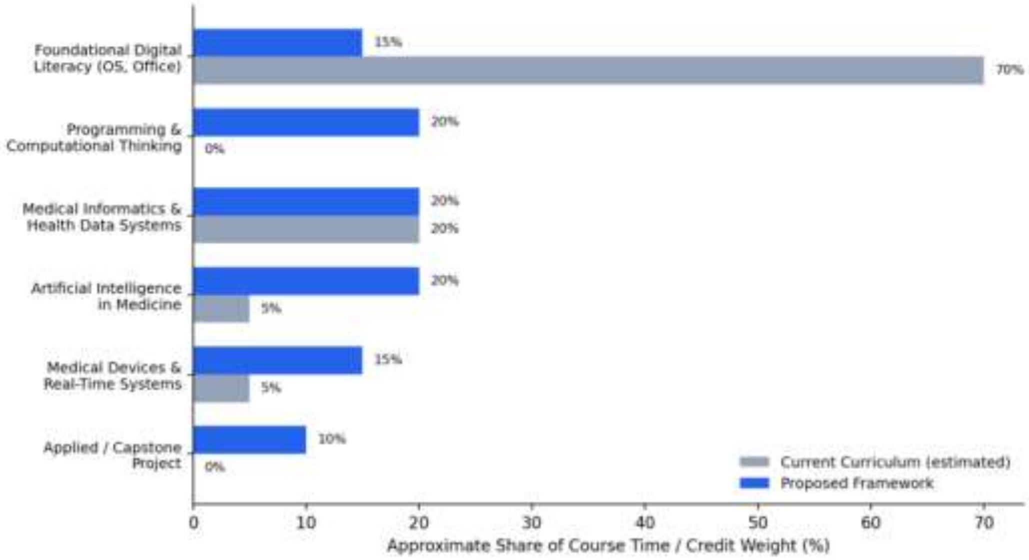

Figure 2. Current curriculum allocation versus proposed allocation in the six domains.

Domain-by-Domain Rationale

Foundational digital literacy remains as a component of the framework, but is reduced from approximately 70% to 15% of weighting in the course. Basic OS and Office skills are sometimes important skills to open the door to some incoming students, but these skills are now in much greater demand before the university and it is often hard for any university to justify dedicating most of a specific medical-school course to these skills today.

The weightage for CT and introduction to Programming is 20 %. This content is somewhat consistent in the literature for developing literacy in assessing clinical tools that utilize computing and artificial intelligence, but not when presented as a formal programming class in the syntax-first, general-purpose style of programming [15, 17].

The portion of medical informatics and health data systems remains approximately 20%. It is already the most successfully contextualized part of the curriculum – the MEDLINE/PubMed unit in particular – and the change being proposed here is mostly a formalization: in the proposed step, this ought to be done more like a hands-on lab, and less like a compendious and distracting lecture.

The rate of curricular activity in AI in medicine rises from approximately 5 to 20 percent, corresponding to the volume of curricular activity in this domain around the world [9] and also, more or less, to the volume of literature showing favorable conceptual and ethical literacy in the use of this technology, —including its capacity to interact with and analyze patients' Dialogues—rather than technical skills [12].

Medical devices and real-time systems expand from ~5% to 15%, on the basis of the operating-systems lecture already offers examples of "ICU-devices". In general, the material that has been added is not of a technical nature, but rather is a conceptual tying together of aspects of real-time constraints in hard devices such as ventilators and cardiac monitors and those in soft devices, and it does not break new ground in a curriculum that already provides concepts for contextualization.

Added at 10% weighting is an applied capstone project. This is in relation to the total absence of any integrative task in the existing curriculum (Table 2) and the low discriminatory power which is reported by the students in the final practical exam (Table 3), as the students were asked to perform skills from different domains in one item graded all in one shot.

Sample Practical Session Mapping

Table 7 illustrates one possible reconfiguration of the current 20-session structure of the practical-lab course to achieve this without increasing the contact hours: To reanchor the existing Office-application course within the clinical tasks, and to add computational-thinking, AI-appraisal, and capstone sessions where the current PowerPoint block is contained.

Table 7. Practical session illustration mapping with the suggested framework.

Week(s)	Practical Session Focus	Domain
1–3	Reframed clinically based file and data organization with simulated patient-record folder structure, retaining the same Windows-skill objective	Foundational literacy
4–6	Writing and formatting a clinical case report in Word, structured data entry and simple charting of simulated vital-sign data in Excel	Foundational → Informatics
7–9	Essentials of CT using a visual/block-based approach, and then basic Python introduced using a guided notebook to carry out simple medical calculation (such as BMI).	CT
10–12	Structured search laboratory in MEDLINE/PubMed (Boolean search, MeSH terms) and a graded search task.	Medical informatics
13–15	The guided exploration of a demonstration tool that is designed to use diagnostic-AI involves a structured critical-appraisal worksheet.	AI in medicine
16–18	Case walk throughs on the operating principles of the ICU/monitoring devices to understand real time system constraints.	Medical devices
19–20	Merging a literature search and a context based on a small set of data into a Case Presentation to end the miniproject for the Capstone.	Applied project

Discussion

Feasibility and Alignment with the Wider Literature

This case study clearly demonstrates that the reform process doesn't necessarily need to begin from scratch. As seen in the 2025–2026 lecture material, real contextualisation using literature analysis (the MEDLINE/PubMed unit in particular) does not require any formal revision of the curriculum but is the result of a personal initiative taken by an individual teacher.

That reflects a trend across the fields of AI use, namely of informal, bottom-up testing of AI use that often occurs before the formal institutional policy follows [23], and sometimes before the institutional policy follows student usage trends [24] before institutional policy, such as DECODE [3], formulated. In this sense, the structure proposed here is not very much a redesign from the outside as a formalization and development of a tendency that may already be present.

The lack of content in the field of CT, even programming is a substantially lacking field when compared to the general literature, but the proposed here is a modest step.: an introduction to Python, supported by notebook-based scaffolding, used for simple clinical determination, rather than a general course of programming. This aligns with a literature, which differentiates between literacy of AI/data for all physicians and more technical training that can be left to specialized or postgraduate programs [12], and with evidence that exposure to programming, when framed positively and kept non-mandatory, tends to generate best attitudinal and computational-thinking result for medical-field learners than a mandatory, high-stakes course [15], [16].

There's a fair question to ask about feasibility of a single, resource-constrained course. Unlike some other low-resource programming curricula [20], [25], this propose does not require additional contact hours; instead, it repurposes the existing practice lesion (Table 7) and relies on freely available demonstration tools and cloud-based notebook environments, which allow learning to proceed without specialized person in clinical AI software.

The actual cost of the real resources lies on the faculty side, with instructors of the computational-thinking and AI-appraisal units needing structured training, or co-teaching with colleagues in data-science or biomedical-engineering more generally, consistent with the AI-in-medical-education literature for designing an interdisciplinary curriculum in general [12].

Implications for Assessment Design

The mean score for the discriminatory ability of the practical exam (Table 3) is dismal at 2.67/5 and thus affects more than this course. When students tell you that a practical or skills-based exam is not differentiating between students, it's a huge indicator that a practical or skills-based exam is not doing what a grading system is supposed to do for students, instructors, and curriculum committees. This reading rests on student-reported perception of the exam rather than on an independent psychometric analysis of the score distribution itself, and should be treated accordingly. It is suggested here that the final practical exam be redesigned as a single integrated task (a MEDLINE/PubMed search, a brief data summary on a small spreadsheet and a short slide presentation [Table

7]) rather than using multiple tasks, which would ensure that the intended learning of the Office skills is maintained but require students to put them all into practice for a purpose. The task requires multiple sub-skills to be performed, and this should increase the range of possible scores and enhance the likelihood that students' scores will reflect authentic differences in ability, in line with other principles of assessment design that prefer integrated, authentic tasks over a sequence of separate component tests.

National Curriculum Standardization, Institutional Flexibility, and Student Mobility

There is a further practical constraint in the governance of undergraduate medical curricula in Iraq. The computer science course is delivered within a nationally guided curricular structure designed to ensure comparability between medical colleges, and the traditional practical elements of the course (Word, Excel, Access, PowerPoint) are set along the same lines rather than locally developed. This standardization is useful both for course equivalence and for students transferring between Iraqi institutions, but it also means that no individual institution, or individual instructor, can simply substitute its own content without approval from the relevant authority.

Major substitutions to the current prescribed syllabus – programming, informatics of medical, analysis of health data, applied AI – could produce a mismatch between a locally revised syllabus and that of other medical colleges. This could complicate transfer between universities and credit recognition for the course when its content, not only its title and credit hours, differs from the receiving institution’s expectations, and in some various cases could need a student to repeating the course.

This does not diminish the argument for reform presented in Sections 4 and 5, but it does help to paint a picture of what a realistic, not ideal, reform would look like. The proposed framework does not require Misan, or any single college, to create a new local curriculum that is completely separate from the curriculum framework that was adopted by the state. A more viable model would maintain the nationwide uniformity of key digital-literacy skills and core assessment expectations that are already known across Iraqi medical colleges, along with a more constrained institutional-enrichment element: applying these digital skills within the medical context, a modest introduction to programming, the introduction of AI concepts in medicine, and information on medical devices, as set out in Table 6.

This is the same reasoning that already appears in Table 7, where the extra domains are incorporated on top of the current structure of 24 sessions in a practical. This change, if it is made formally, not as an add-on by an individual instructor, but through the established curriculum-approval process of the college and university, would also help maintain a readable, college-level syllabus for other colleges and universities making course-level equivalency determinations, and, ideally, also coordinate with peer colleges of medicine so that the shared national core does not grow independent of one another.

CONCLUSION

Fundamental Finding: The student survey provides direct, first hand accounts from 201 students of how some students lack a real alignment between the parts of the six-domain framework they need and have access to with the parts that are actually assessed in this course, while providing clear evidence, in the form of the priorities ranking, of which aspects of the six-domain framework students want most. **Implication:** The structural trend suggested in the computer science curriculum in this study is not likely at all to be unique to Misan, as the course was explained by the general concept of digital literacy, and gradually reworked to include a medical informatics focus, especially evident in the well-structured biomedical literature search unit, most likely at an initiative of the teachers themselves. **Limitation:** The study is limited to the experiences of 201 students and the assessment alignment within a specific computer science course in Misan. **Future Research:** Future research could examine similar curriculum trends and student needs across other institutions and contexts to determine whether the integration of digital literacy and medical informatics is more broadly applicable.

REFERENCES

[1] J. Mantas *et al.*, "Recommendations of the International Medical Informatics Association (IMIA) on education in biomedical and health informatics: First revision," *Methods of Information in Medicine*, vol. 49, no. 2, pp. 105-120, 2010.

[2] J. Bichel-Findlay *et al.*, "Recommendations of the International Medical Informatics Association (IMIA) on education in biomedical and health informatics: Second revision," *International Journal of Medical Informatics*, vol. 170, art. no. 104908, 2023.

[3] J. Car *et al.*, "The digital health competencies in medical education framework: An international consensus statement based on a Delphi study," *JAMA Network Open*, vol. 8, no. 1, art. no. e2453131, 2025.

[4] H. Zainal, X. Xiaohui, J. Thumboo, and F. Kok Yong, "Digital competencies for Singapore's national medical school curriculum: A qualitative study," *Medical Education Online*, vol. 28, no. 1, art. no. 2211820, 2023.

[5] I. J. Borges do Nascimento *et al.*, "Barriers and facilitators to utilizing digital health technologies by healthcare professionals," *npj Digital Medicine*, vol. 6, no. 1, art. no. 161, 2023.

[6] A. Mainz, J. Nitsche, V. Weirauch, and S. Meister, "Measuring the digital competence of health professionals: Scoping review," *JMIR Medical Education*, vol. 10, art. no. e55737, 2024.

[7] P. Veikkolainen *et al.*, "The evolution of medical student competencies and attitudes in digital health between 2016 and 2022: Comparative cross-sectional study," *JMIR Medical Education*, vol. 11, art. no. e67423, 2025.

[8] K. Lawrence and D. L. Levine, "The digital determinants of health: A guide for competency development in digital care delivery for health professions trainees," *JMIR Medical Education*, vol. 10, art. no. e54173, 2024.

[9] J. Simoni *et al.*, "Artificial intelligence in undergraduate medical education: An updated scoping review," *BMC Medical Education*, vol. 25, art. no. 1609, 2025.

[10] Y. M. Lee *et al.*, "Defining medical AI competencies for medical school graduates: Outcomes of a Delphi survey and medical student/educator questionnaire of South Korean medical schools," *Academic Medicine*, vol. 99, pp. 524-533, 2024.

[11] J. Lee, A. S. Wu, D. Li, and K. M. Kulasegaram, "Artificial intelligence in undergraduate medical education: A scoping review," *Academic Medicine*, vol. 96, pp. S62-S70, 2021.

[12] R. Tolentino, A. Baradaran, G. Gore, P. Pluye, and S. Abbasgholizadeh-Rahimi, "Curriculum frameworks and educational programs in AI for medical students, residents, and practicing physicians: Scoping review," *JMIR Medical Education*, vol. 10, art. no. e54793, 2024.

[13] A. L. Farmakidis, A. Singh, K. Leaf, and A. Rossi, "Artificial intelligence curricula in U.S. and Canadian medical schools," *AAMC Curriculum SCOPE Survey Report*, 2025.

[14] B. Almehmadi, T. M. Bakhsh, I. N. Elahi, and N. Hariri, "Awareness, perceptions, and opinions of artificial intelligence among undergraduate medical students at Umm Al-Qura University, Saudi Arabia, in 2025: A cross-sectional study," *Cureus*, vol. 17, art. no. e89741, 2025.

[15] C.-H. Lai, Y.-K. Chen, Y.-H. Wang, and H.-C. Liao, "The study of learning computer programming for students with medical fields of specification, an analysis via structural equation modeling," *International Journal of Environmental Research and Public Health*, vol. 19, no. 10, art. no. 6005, 2022.

[16] A. Althewini and O. Alobud, "Exploring medical students' attitudes on computational thinking in a Saudi university: Insights from a factor analysis study," *Frontiers in Education*, vol. 9, art. no. 1444810, 2024.

[17] Y. Pan and J. Harun, "Conquering coding fears: A systematic review of programming anxiety in higher education," *Journal of Information Technology Education: Research*, vol. 24, art. no. 20, 2025.

[18] C.-J. Wang, H.-X. Zhong, P.-S. Chiu, J.-H. Chang, and P.-H. Wu, "Research on the impacts of cognitive style and computational thinking on college students in a visual artificial intelligence course," *Frontiers in Psychology*, vol. 13, art. no. 864416, 2022.

[19] P. Gough, O. Bown, C. R. Campbell, P. Poronnik, and P. M. Ross, "Student responses to creative coding in biomedical science education," *Biochemistry and Molecular Biology Education*, vol. 51, no. 1, pp. 44-56, 2023.

[20] M. Duda *et al.*, "Teaching Python for data science: Collaborative development of a modular & interactive curriculum," *Journal of Open Source Education*, vol. 4, no. 46, p. 138, 2021.

[21] A. Nichat, U. Gajbe, N. J. Bankar, B. R. Singh, and A. K. Badge, "Flipped classrooms in medical education: Improving learning outcomes and engaging students in critical thinking skills," *Cureus*, vol. 15, no. 11, art. no. e48199, 2023.

[22] M. H. Bhavsar, H. N. Javia, and S. J. Mehta, "Flipped classroom versus traditional didactic classroom in medical teaching: A comparative study," *Cureus*, vol. 14, no. 3, art. no. e23657, 2022.

[23] M. A. Blanco *et al.*, "Integrating artificial intelligence into medical education: A roadmap informed by a survey of faculty and students," *Medical Education Online*, vol. 30, no. 1, art. no. 2531177, 2025.

[24] G. Rueff, P. Monaco, A. E. Rusinol, and M. Hernandez, "Challenges in the rapid and responsible integration of generative artificial intelligence (AI) into a new medical school curriculum," *Cureus*, vol. 17, art. no. e86796, 2025.

[25] N. S. Osório and L. D. Garma, "Teaching Python with team-based learning: Using cloud-based notebooks for interactive coding education," *FEBS Open Bio*, vol. 15, pp. 2054-2066, 2025.

[26] University of Misan, College of Medicine, "Computer Science course syllabus, first stage," Unpublished internal document, 2025-2026.

[27] University of Misan, College of Medicine, "Lecture materials: Fundamentals of information technology; History and evolution of computers; Introduction to operating systems; The internet and communication; Internet applications in medicine and healthcare; Data communication; Computer-based medical systems and artificial intelligence in diagnosis; MEDLINE and PubMed biomedical literature search," Unpublished internal teaching materials, 2025-2026.

[28] University of Misan, College of Medicine, "Student survey on computer science curriculum perceptions and priorities," Unpublished internal dataset, $n = 201$, 2025-2026.

[29] D. J. Hawezy, K. A. Mahmood, G. A. Hawezy, G. Sadraldeen, and S. T. Ahmad, "Medical students' perception toward using AI in medical education in the Kurdistan region, Iraq: A cross-sectional study," *Cureus*, vol. 16, no. 9, art. no. e70545, 2024.

***Yousif A. Saadoon (Corresponding Author)**
College of Medicine, University of Misan, Amarah, Maysan, Iraq.
Email: yousif@uomisan.edu.iq

Riam H. Saffar
Maysan Directorate, Ministry of Education, Amarah, Maysan, Iraq.
Email: riam.saffar@gmail.com