

Multimedia-Enhanced Web-Based Education Improves Medical Record Documentation Competencies Among Medical Students

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Abstract

High-quality medical documentation is essential for delivering effective patient care, as precise and complete records help minimize medical errors and promote greater patient safety. Because medical records are central to healthcare delivery, robust training in documentation practices is indispensable. Consequently, this study was undertaken to develop and assess a web-based educational program on medical record documentation, aimed primarily at medical students in Iran (West Azerbaijan Province, Urmia), with potential for straightforward adaptation to similar settings. This quasi-experimental investigation took place in 2023 and was structured around three core phases: pre-intervention, intervention, and post-intervention. During the initial phase, researchers designed an online questionnaire to measure knowledge, attitudes, and performance, which was then incorporated into the web-based learning platform. In the intervention phase, researchers developed and provided multimedia digital materials to participants for two months. In the final phase, the identical online questionnaire was re-administered. The sample consisted of 114 medical students from Urmia University of Medical Sciences. Of these participants (61 externs and 53 interns), 53.4% were male, and 46.6% were female. All data were processed using SPSS version 16. After the intervention, mean knowledge scores rose from 76.50 to 86.30, attitude scores increased from 79.33 to 85, and performance scores improved from 74.92 to 81.40. Statistical testing confirmed that the web-based training produced significant positive effects on students' knowledge, attitudes, and performance in documentation ($P < 0.05$). This study demonstrates that web-based learning supported by multimedia content can substantially enhance medical students' knowledge, attitudes, and performance in medical record documentation. While the favorable results highlight the value of the program's design features, additional research is necessary to firmly establish causality. Further investigations in this domain are advisable. Overall, adopting such instructional strategies appears vital for cultivating strong documentation competencies among the next generation of healthcare professionals. This work may also stimulate new educational approaches and encourage targeted research in adjacent fields involving intricate documentation processes.

Keywords: Medical record documentation, Web-based education, Medical students, E-learning, Multimedia education, Knowledge

Introduction

Medical records are a cornerstone of healthcare organizations, serving as the principal and most complete repository of information for the diagnosis, treatment,

and ongoing monitoring of diseases [1]. These records contain comprehensive details regarding symptoms, medical histories, laboratory findings, diagnoses, and therapeutic interventions as recorded by healthcare providers [1, 2]. Serving as authoritative documents, medical records allow clinical teams to evaluate care processes, facilitate effective communication among stakeholders, and ensure continuity of patient management [3, 4].

Furthermore, the information embedded in medical records supports multiple facets of healthcare administration, such as professional education, scientific

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research, public health programs, institutional assessments, and risk mitigation strategies [5, 6]. This includes domains such as complaint resolution, litigation proceedings, and promoting patient safety [5]. Indeed, existing scholarship emphasizes the importance of clear, precise, and confidential documentation practices, as deficiencies in these areas may result in serious consequences, including modifications to treatment plans, redundant procedures, increased expenditures, legal liabilities, and even patient mortality [6-8].

Nevertheless, despite widespread acknowledgment of the value of high-standard documentation, considerable difficulties remain [8]. Common problems include incomplete or inaccurate entries, vague terminology, and improper use of medical abbreviations; in each case, these shortcomings can lead to misunderstandings and clinical errors [9]. According to the World Health Organization (WHO), roughly 75% of adverse events in patient care arise from mistakes committed by healthcare workers [10]. In the United States, documentation and medication errors are estimated to contribute to the death of at least one patient each year [11].

For instance, research by Demsash *et al.* [7] found that 33.3% of medical students in Indonesia possessed insufficient documentation competencies [7]. Comparable outcomes have been documented in Iran, where healthcare personnel's medical record documentation standards frequently fall below acceptable levels [12-14]. For example, Mahmoudian *et al.* [15] found that documentation standards were not followed in 64.8% of emergency department records [15]. Similarly, Abbaszadeh *et al.* [12] identified a 42% deficiency rate across various documentation categories [12].

Errors in recording patients' medical information pose a substantial threat to patient safety and overall healthcare quality, especially in developing nations where health systems face distinctive constraints [16]. Typical inaccuracies involve dictation errors, illegible handwriting, indiscriminate copy-pasting in electronic health records (EHRs), misfiled documents, and medication inconsistencies [17, 18]. Such flaws may culminate in misdiagnoses, unsuitable therapies, and erosion of patient confidence [18]. In resource-limited settings, limited funding and insufficient training intensify these problems [19], with many healthcare institutions still relying on outdated paper-based systems [20]. Investigations reveal that many healthcare practitioners lack sufficient awareness of the significance

of meticulous record-keeping, which fosters under-reporting of errors and perpetuates an organizational culture that undervalues patient safety [17, 18, 20]. Hence, addressing these obstacles is vital to improving healthcare outcomes and establishing a more reliable medical record framework.

Given the pivotal contribution of medical records to elevating healthcare standards, instruction in documentation skills is widely regarded as indispensable [7, 21]. Consequently, choosing a suitable pedagogical method is a critical stage in developing effective training initiatives [22].

With advances in information technology, e-learning has gained importance in medical education by offering greater flexibility, stimulating creative thinking, promoting independent learning, and improving access to information [23, 24]. Notably, web-based education has proven more efficacious than conventional clinical internships in improving students' learning achievements [25]. For example, a 2023 investigation by Ayten *et al.* [26] established that web-based instruction markedly enhanced students' documentation abilities [26]. In addition, Mauro *et al.* [27] reported that 82.5% of students favored electronic training over traditional approaches, underscoring its capacity to fulfill educational requirements [27].

Accurate medical record documentation remains indispensable for safeguarding patient safety and ensuring optimal healthcare delivery, particularly because medical students—including externs, interns, and residents—play a key role in this domain. Thorough preparation in documentation competencies is therefore essential [28, 29]. However, notable shortcomings in these abilities have been identified among medical students and practicing clinicians in developing countries [30, 31]. As previously noted, elements such as insufficient instruction, incomplete entries, and the misuse of medical abbreviations contribute to mistakes that may negatively affect patient outcomes [22, 30, 31]. This study was designed to address these urgent issues by creating multimedia-based training modules intended to strengthen the documentation skills of medical students at Urmia University of Medical Sciences. By emphasizing sound instructional design, the objective was to improve the quality of healthcare services and, ultimately, patient care and safety.

Materials and Methods

In 2023, researchers performed a quasi-experimental investigation to examine medical students' knowledge, attitudes, and performance levels related to medical record documentation. A total of 139 participants, comprising both externs and interns at Urmia University of Medical Sciences in West Azerbaijan, Iran, took part in the study. Cluster sampling was applied to recruit students from two university-affiliated hospitals: Motahari and Kowsar.

Pre-intervention assessment

Pre-intervention data were gathered using a custom-designed questionnaire created on Google Forms. The tool was divided into three distinct parts:

1. Knowledge Assessment: This portion featured 20 multiple-choice items concerning medical record documentation. Correct responses earned five points each, whereas incorrect answers received no credit.
2. Attitude Evaluation: Attitudes were measured via 20 statements rated on a Likert scale from "strongly disagree" (1) to "strongly agree" (5).
3. Performance Measurement: Performance was appraised through another 20 Likert-scale items with response options ranging from "never" (1) to "always" (5).

Content validity was evaluated using the Content Validity Index (CVI), yielding scores of 98% for relevance, 96.5% for simplicity, and 98% for clarity. The Content Validity Ratio (CVR) for item necessity reached 85%. Instrument reliability was verified through a test-retest procedure involving 15 students over 10 days, producing a Cronbach's alpha of 0.85.

The intervention was conducted on the Learning Management System (LMS) maintained by Urmia University of Medical Sciences. A specialized course named "Medical Record Documentation" was established, with all 139 medical students enrolled. We then distributed an online questionnaire, designated as "Assignment," accessible only after students logged in with their personal credentials. Ultimately, 114 students (61 externs and 53 interns) engaged in the intervention. We analyzed questionnaire responses in Google Forms after two weeks. To pinpoint specific learning needs, we assembled an expert panel of 11 members. This group conducted several focused discussions to interpret the baseline results and define the specifications for the digital educational resources.

Intervention phase

Panel discussions emphasized the need to focus on patients' primary records, incorporate engaging animations, and present examples of properly confidential documentation. Informed by these recommendations, the researcher created seven micro-learning modules using Articulate Storyline software (version 3.12) (**Figure 1**). The covered topics were:

1. Introduction to Medical Record Documentation (5:34 min)
2. Documentation Laws and Principles (7:55 min)
3. Documentation Principles in Summary Sheets (8:46 min)
4. Medical History and Physical Examination (part1 = 6:82 min and part2 = 8:11 min)
5. Progress Notes (6:42 min)
6. Physician Orders (9:14 min)

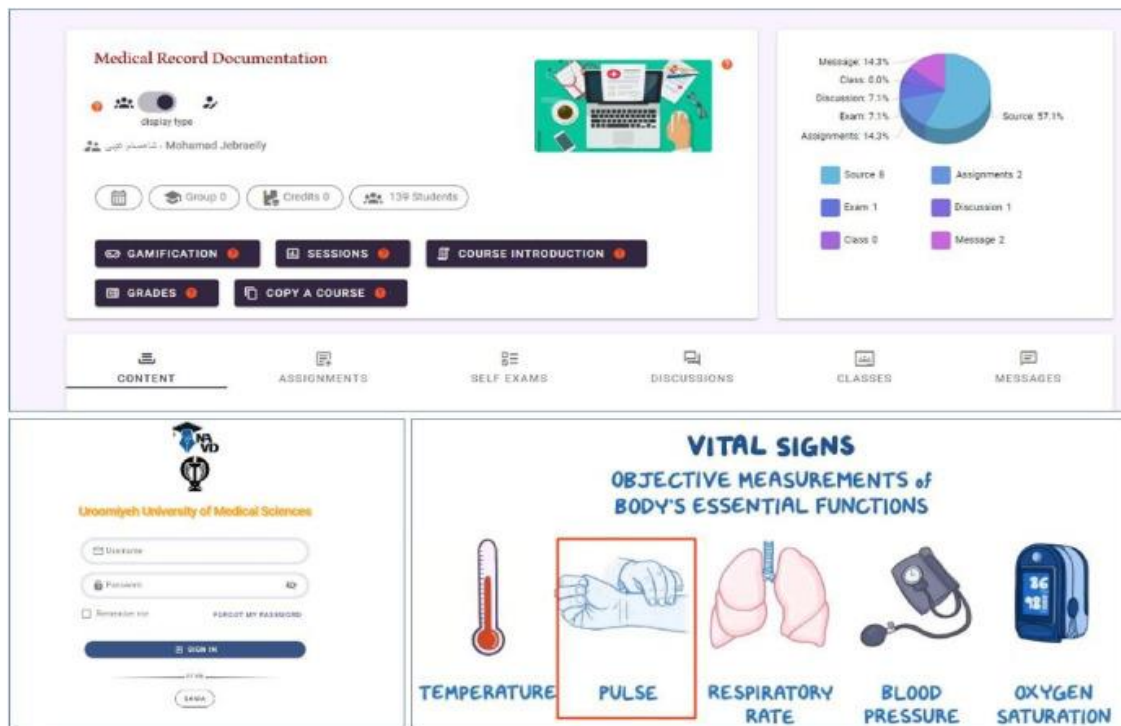


Figure 1. Representative screenshots of the web-based training program developed for medical record documentation.

The modules featured practical, anonymized illustrations derived from real patient records and were integrated into the LMS. During integration, participants received comprehensive guidance on the course content, research objectives, and platform navigation, supplemented by a detailed user manual to support effective engagement with the materials.

Throughout the two-month intervention window, learners had continuous access to the educational content and undertook a self-assessment exercise containing ten multiple-choice questions. Furthermore, an interactive forum was established to allow students to submit inquiries and receive timely responses.

Design of training courses (multimedia)

To optimize the impact of the training modules, a set of precise design guidelines was defined for the multimedia educational units. These guidelines were grounded in recognized theories of multimedia instruction, chiefly Richard Mayer's 12 Principles of Multimedia Learning, which aim to reduce unnecessary cognitive burden and heighten learner involvement [32].

Special attention was given to controlling cognitive load. All information was arranged in a logical, well-structured sequence to reduce irrelevant mental effort, enabling

students to focus on grasping the subject matter rather than contending with disorganized presentation [33]. Such organization supports more efficient knowledge acquisition without causing learner fatigue.

Multimedia elements were deliberately combined, merging visual displays with audio narration. This dual-channel approach was intended to boost retention while eliminating unnecessary duplication, for example, by avoiding the verbatim reading of on-screen text [34]. Presenting concepts through complementary formats also addressed varied individual learning preferences.

Active participation was promoted through interactive components such as embedded quizzes and self-assessment tasks [35]. These features stimulated engagement and helped solidify understanding by permitting learners to apply ideas immediately and evaluate their own progress.

The content was deliberately divided into short, self-contained modules, each addressing a defined learning objective [36]. This segmented format allowed learners to process information in manageable portions, preventing overload and supporting smoother educational progression.

Visual design received equal emphasis to sustain attention. Attractive, coherent graphical layouts were

chosen to capture interest while remaining consistent with the instructional purpose. An appealing interface markedly improves the overall learning atmosphere [37]. Furthermore, the platform featured straightforward and user-friendly navigation tools. Clear pathways enabled effortless movement across different sections and materials. Detailed directions and a supporting user manual were included to minimize confusion, ensuring participants could focus their energy on mastering the content itself. Finally, the program built in continuous feedback opportunities through regular quizzes and evaluations. Immediate responses allowed learners to track their development and pinpoint specific areas for growth. This ongoing cycle is essential for strengthening acquired skills and motivating sustained improvement. Overall, these carefully chosen design features were intended to deliver information effectively while creating a dynamic and encouraging environment for medical students.

Post-intervention phase

After the two-month training period, participants completed a “Post-Intervention Questionnaire” that replicated the structure and content of the earlier assessment. The identical group of 114 students who had taken part in the baseline evaluation completed this second survey to measure the outcomes of the educational initiative.

Data analysis and statistical approach

Statistical processing of the study data was performed using SPSS Statistics 16, concentrating on comparisons between pre- and post-intervention scores for knowledge, attitudes, and performance. Paired-sample t-tests served as the primary method to determine the effectiveness of

the web-based training intervention and its influence on students’ results.

This statistical approach is especially appropriate for the current quasi-experimental setting, as it enables direct evaluation of average scores from the same individuals before and after the training. By assessing shifts in knowledge, attitude, and performance metrics, the analysis aimed to determine whether the web-based program led to meaningful improvements in participants’ abilities and understanding of medical record documentation.

Results and Discussion

Statistical analysis of the descriptive data from the online questionnaires administered before and after the intervention included 139 medical students in total, with 114 completing the full program. Of these 114 active participants, 56.1% were male, and 43.9% were female. The predominant age bracket was 25–29 years, accounting for 48.2% of the sample. The group comprised 61 externs and 53 interns, representing varied stages of clinical training. In terms of digital competence, 53.5% of the students described their computer skills as average.

The web-based education and medical students’ knowledge

Evaluation of medical students’ comprehension of medical record documentation showed a pronounced improvement after program participation. Correct answer rates advanced from 77% to 88.15%, while incorrect responses fell sharply from 23% to 11.85%. Mean knowledge scores likewise demonstrated a notable rise, advancing from 76.50 to 86.30 (**Table 1**).

Table 1. Influence of the intervention on medical students’ knowledge regarding medical record documentation.

Participant group	Before intervention			After intervention			Pre-Post difference (SD)	df	t-value	P-value
	n	Average	SD	n	Average	SD				
Extern students	61	82.45	16.40	61	90.50	6.15	17.60	60	-5.22	<0.005
Intern students	53	70.55	19.20	53	82.10	5.10	20	52	-4.56	<0.005
Overall	114	76.50	17.80	114	86.30	5.62	10.25	113	-7.02	<0.005

The observed outcomes affirm the capacity of web-based instruction to strengthen medical students’ knowledge, attitudes, and performance in medical record documentation. Importantly, these improvements were statistically significant ($P < 0.005$).

The web-based education and medical students’ attitudes
An investigation into medical students’ viewpoints on medical record documentation showed that roughly half attributed gaps in record completeness to limited prior instruction. The educational program brought about a meaningful transformation in these perceptions.

Initially, only 55.3% of participants recognized the favorable consequences of high-quality documentation for patient care standards. This perception increased to 60.5% after exposure to the web-based training. Although positive shifts were evident throughout the cohort, extern students experienced smaller changes in attitude than interns.

Findings from the 114 medical students confirmed that the web-based education produced a considerable and statistically significant impact ($P < 0.005$) on attitudes toward medical record documentation (**Table 2**). These results show how well-designed educational initiatives can reshape the outlooks of emerging healthcare practitioners and contribute to better clinical outcomes.

Table 2. Influence of the intervention on medical students' attitudes regarding medical record documentation.

Participant category	Baseline assessment			Follow-up assessment			Baseline–follow-up difference (SD)	df	t statistic	P-value
	n	Mean Score	SD	n	Mean Score	SD	SD			
Externs	61	85.2	11.19	61	89.65	12.79	18.27	60	-1.88	>0.005
Interns	53	72.5	9	53	80.35	11.97	14.57	52	-5.7	<0.005
Overall Cohort	114	79.33	12.01	114	85	12.45	17.34	113	-4.7	<0.005

The web-based education and medical students' performance

Performance metrics illustrated a clear benefit arising from the training. During the initial assessment, just 26.3% of students regularly noted prior medication dosages within progress notes. Post-intervention, this rate climbed to 38.6%.

Similarly, documentation of the patient's status at discharge in the summary sheet increased from 8.8% to 16.7% after the program.

While paired sample t-tests did not detect a statistically significant effect among internal students ($P > 0.005$), the collective data for all 114 participants revealed meaningful gains. Overall performance averages advanced from 74.92% to 81.40%, confirming a positive and statistically significant enhancement in documentation proficiency ($P < 0.005$) (**Table 3**).

Table 3. Influence of the intervention on medical students' performance in medical record documentation.

Student group	Before the educational intervention			After the educational intervention			Pre–post change (SD)	Degrees of freedom (df)	t-value	P-value
	n	Average	SD	n	Average	SD	SD			
Extern Students	61	82.42	16.63	61	88.68	14.28	14.04	60	-5.03	<0.005
Intern Students	53	72.5	16.81	53	75.01	15.38	17	52	-2.32	>0.005
Entire Sample	114	74.92	17.85	114	81.40	20.78	16.25	113	-6.71	<0.005

The impact of web-based training program on medical students

The present analysis demonstrates that the mean scores reflecting the influence of web-based training on knowledge, attitudes, and performance in medical record documentation are highly encouraging. As shown in

Figure 2, the program produced notable gains in medical students' knowledge, attitudes, and performance concerning medical records. These favorable changes emphasize the value of web-based instruction in cultivating vital documentation competencies among prospective healthcare providers.

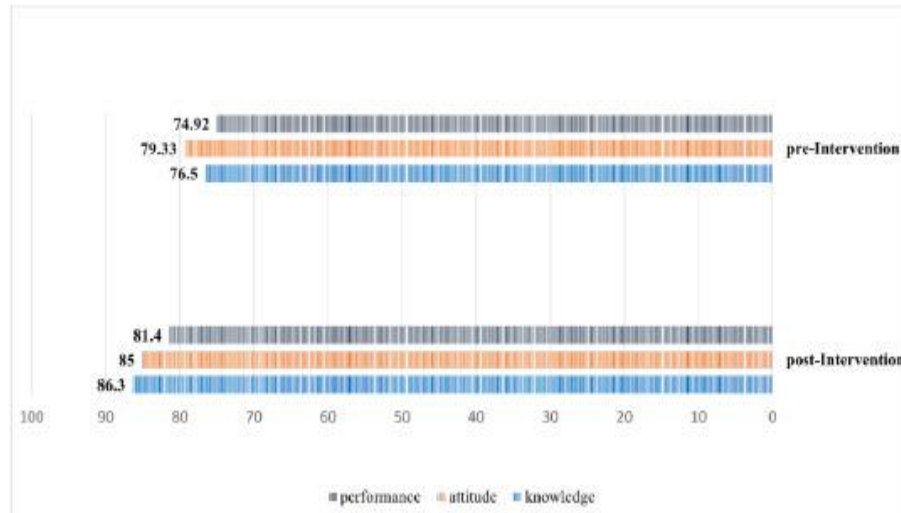


Figure 2. Effect of the web-based training program on medical students' knowledge, attitudes, and performance in medical record documentation.

The current investigation employed a quasi-experimental design organized into three successive stages: pre-intervention, intervention, and post-intervention. The outcomes clearly show that web-based education yields significant improvements in knowledge, attitudes, and performance related to medical record documentation.

These findings are consistent with earlier research in the domain. For example, Brateanu *et al.* [38] conducted a 2019 study in the United States that examined the use of online learning to strengthen medical students' documentation abilities. Fifty-four residents were assigned to either a control group ($n = 27$) receiving only a PDF document or an experimental group ($n = 27$) receiving the PDF plus supplementary online materials. The experimental group exhibited markedly greater gains in knowledge of medical record documentation than the control group, supporting the conclusions of the present research and confirming the utility of web-based approaches for developing documentation proficiency among healthcare trainees [38].

In a 2021 Canadian study, Hayward *et al.* [39] investigated the effects of electronic learning on oncology specialists' knowledge, attitudes, and documentation performance. The researchers applied a three-part Likert-scale questionnaire and delivered electronic educational materials over four months. Post-intervention results indicated modest improvements: knowledge increased by 4.23%, attitudes by 1.27%, and performance by 3.03%. While knowledge and performance improved, attitudes did not shift significantly [39].

By comparison, the present study achieved considerably larger gains, with knowledge rising by 10%, attitudes by 6%, and performance by 7%. These marked differences highlight the strength of the current instructional design in producing comprehensive advancements across all three dimensions.

Unlike many prior investigations that addressed a wide spectrum of healthcare workers, this research specifically targeted intern and extern medical students. One relevant comparison is Rachman *et al.* [40], which assessed online training for dietitians' documentation of nutritional care in the USA. Eighty nutrition professionals with at least a bachelor's degree and six months of experience participated. Following a two-month program featuring videos, PowerPoint presentations, animations, and case studies, documentation knowledge among nutrition specialists increased by 80% [40].

In the present study, medical students' knowledge scores rose from 76.50 to 86.30, representing a substantial improvement. This outcome demonstrates the effectiveness of tailoring web-based interventions to medical students' learning needs and preferences, thereby establishing a higher standard for documentation training in healthcare education.

Another comparable investigation by El-Ali *et al.* [41] in 2019 in the United States compared traditional and web-based education among radiology residents. Forty-seven residents were randomly assigned to a web-based group ($n = 24$) or a traditional workshop group ($n = 23$). Both groups completed a 16-item questionnaire before and after the educational sessions that incorporated real

clinical cases and radiological images. The results indicated that web-based learning led to significant knowledge gains, with the workshop-based method producing a 77% increase in documentation knowledge in that particular study [41].

However, the present investigation exceeded this benchmark by achieving an even greater gain in documentation knowledge, rising from 76.50% to 86.30% following the web-based intervention. This result strongly highlights the effectiveness of the educational strategy used in the current study in strengthening medical students' grasp of and practical application of documentation principles. Drawing upon the key advantages of web-based learning—such as interactivity, multimedia resources, and flexible pacing—the researchers developed a more impactful and engaging instructional experience. As a result, the intervention produced greater advances in documentation knowledge than those observed in prior studies that relied primarily on conventional or workshop-based formats.

In addition, the researchers prepared detailed electronic materials covering a broad range of documentation principles and regulatory requirements. These resources explored the nuances of summary sheet documentation, medical history taking, disease progression notes, and medical instructions. By fostering a deep understanding of these fundamental areas, the study sought to provide students with the essential competencies required for high-quality medical record documentation. The data presented, along with their statistical evaluation, support the study's objectives.

In comparison, Vahedi *et al.* [42] applied a more conventional method in Iran to examine the effects of training on medical students' documentation practices. Their approach involved a 3-day workshop that presented documentation principles through examples based on AHIMA (American Health Information Management Association) and WHO (World Health Organization) guidelines, utilizing both electronic and traditional teaching techniques. One month after the workshop, the researchers reviewed 300 student-generated records to evaluate the training's impact. The findings were notable, showing an increase in student performance from 77% to 99%. Although the study by Vahedi *et al.* [42] confirmed the value of in-person training, it did not incorporate the NCQA (National Committee for Quality Assurance) guidelines [42] that were included in the present research. The web-based training implemented in the current study has similarly delivered promising outcomes, with student

documentation performance improving by 81.4%. These results illustrate the capacity of web-based learning to provide effective documentation education, serving as a flexible and accessible option compared with traditional workshop formats.

By using electronic materials and integrating guidelines from AHIMA, WHO, and NCQA, the present study established a comprehensive and engaging learning environment for medical students. The substantial improvement in documentation performance underscores the value of this innovative approach in advancing students' practical skills and theoretical knowledge in medical record documentation.

The investigation utilized the electronic learning platform of Urmia University of Medical Sciences, which included features such as content rating, virtual classes, video conferencing, gaming elements, and self-assessment tools. Various platforms have been developed to support web-based student documentation learning. For instance, a 2015 Australian study by Spieler *et al.* [43] introduced a Java-based web application for physiotherapy documentation. This system enabled professors, students, and administrators to access appropriate sections while preserving patient confidentiality and facilitating feedback on student reports. Its user-friendly design significantly improved documentation quality among physiotherapy students [43].

By contrast, the current study concentrates on medical record documentation and employs video files as a primary educational tool. For completeness, Falagas *et al.* [44] developed an educational website called e-medication in 2015. This platform provided varied medical content and search functionality, thereby improving knowledge levels among students in Greece across several medical disciplines [44].

While earlier research largely depended on workshop-based instruction, the present study demonstrates that web-based education can successfully enhance nursing documentation knowledge, attitudes, and performance among students. Overall, the implemented method effectively raised documentation knowledge from 76.50% to 86.30%, yielding positive effects on students' attitudes and practical performance in medical record documentation.

Limitations

It is appropriate to acknowledge several limitations that point toward avenues for future research. First, self-

administered questionnaires carry the risk of social desirability bias, as participants may have provided responses they considered favorable rather than fully accurate reflections of their knowledge and practices. This tendency could distort the results and undermine the validity of the conclusions. In addition, the study had difficulty comparing its findings with those of other investigations because comparable research in this domain is limited. This shortcoming limits contextualization within the broader literature on medical documentation and limits conclusions about generalisability.

Despite efforts to minimize bias by recruiting data collectors external to the study hospitals, some residual bias may nonetheless have influenced the outcomes. This possibility reinforces the need for rigorous methodological designs in subsequent studies.

Conclusion

The results indicate that students had unsatisfactory baseline levels of knowledge, attitude, and performance related to medical record documentation before the intervention. After the multimedia training course, substantial improvements were observed across all three dimensions.

Although these positive outcomes suggest that specific characteristics of the course contributed significantly to improved students' skills, further investigation is required to confirm direct causality. Nevertheless, the inclusion of engaging multimedia content and interactive features most likely played a major role in these gains by creating a more efficient and motivating learning environment.

These findings emphasize the value of designing curricula that incorporate innovative educational strategies, including multimedia training programs focused on medical record documentation and electronic health records. Such initiatives hold considerable potential to improve documentation practices among students, ultimately contributing to better patient care and clinical outcomes. This study aimed to develop and evaluate a web-based training program on medical record documentation for medical students in hospitals in West Azerbaijan province, Urmia, Iran, and demonstrated its effectiveness; it can be readily adapted for use in other relevant settings.

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