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Integrating Artificial Intelligence into Medical and Dental Imaging Education: A Proposed Curriculum Framework for Undergraduate Medical and Dental Students

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Abstract

Background: Artificial intelligence (AI) is increasingly being integrated into medical and dental imaging, with applications ranging from image acquisition and reconstruction to image analysis, quality assurance, radiation dose optimization, and clinical decision support. Despite this rapid development, AI education remains inconsistently integrated into undergraduate medical imaging and dental curricula, and existing educational initiatives have focused predominantly on postgraduate training.

Objective: This teaching review aims to examine the current educational needs related to AI in medical and dental imaging and to propose an evidence-informed framework for integrating AI competencies into undergraduate education. Particular emphasis is placed on AI literacy, clinical imaging applications, image quality, radiation protection, patient safety, critical evaluation, ethics, regulation, and human–AI collaboration.

Methods: A structured educational literature review was conducted using PubMed/MEDLINE, Scopus, Web of Science, Google Scholar, and relevant additional sources. Publications addressing AI education, AI literacy, medical and dental imaging, radiography, curriculum development, clinical applications, image quality, radiation dose optimization, patient safety, and ethical and regulatory considerations were considered according to predefined eligibility criteria. The identified evidence was thematically synthesized to determine key educational competencies and inform the development of the proposed curriculum.

Results: Forty-three publications were included in the final evidence synthesis. Five overarching educational domains were identified: (1) AI and imaging foundations; (2) AI applications in medical and dental imaging; (3) image quality, radiation protection, and patient safety; (4) critical evaluation, ethics, and regulation; and (5) human–AI collaboration and future professional practice. Based on these domains, two complementary 12-module curriculum models were developed for undergraduate medical imaging and dental imaging education. The proposed framework progresses from fundamental AI literacy to clinically oriented competencies, critical appraisal of AI systems, responsible use, and professional preparedness.

Conclusion: Undergraduate AI education should be progressively integrated into medical imaging and dental curricula rather than treated as an isolated technical subject. The proposed framework provides an adaptable, clinically oriented educational model designed to help future imaging professionals understand, critically evaluate, and responsibly use AI-enabled technologies while maintaining image quality, radiation protection, patient safety, professional judgment, and patient-centered care. Future studies should evaluate the implementation, educational effectiveness, and adaptability of the framework across different institutions and educational settings.

Keywords: artificial intelligence, machine learning, deep learning, medical imaging, dental imaging, undergraduate education, curriculum.

I. Introduction

Artificial intelligence (AI) is rapidly transforming medical and dental imaging, with applications spanning image acquisition, reconstruction, enhancement, interpretation, segmentation, quantitative analysis, workflow optimization, and clinical decision support. The increasing use of machine learning, deep learning, computer vision, and generative AI is changing not only how imaging technologies are developed and implemented but also the knowledge and competencies expected of future imaging professionals. Consequently, AI literacy is becoming an increasingly important component of contemporary imaging education, enabling students to understand the basic principles of AI, recognize its clinical applications, and critically interpret its outputs [1,2].

The need for structured AI education has already been recognized in radiology and medical imaging training. A systematic review published in 2023 identified five AI curricula specifically developed for radiology residents. These curricula included didactic lectures, assigned readings, hands-on learning, and journal clubs, and all studies that evaluated educational outcomes reported positive effects on participants' knowledge or attitudes toward AI [1]. Similarly, surveys of radiology trainees have demonstrated substantial interest in formal AI education. One national survey reported that 84.8% of respondents believed that AI and machine-learning knowledge should be taught during radiology residency, while 59.2% considered that their current programs had not adequately implemented AI education [3, 4]. These findings indicate that AI education is increasingly regarded as an essential component of contemporary imaging training rather than an optional area of specialization.

However, the existing educational literature remains predominantly focused on postgraduate radiology training. Although several curricula and educational frameworks have been developed for radiology residents, their content, structure, and implementation vary considerably, and there is no universally standardized approach to AI education across training programs [1,3]. Recent reviews of AI education in medicine have similarly highlighted the limited availability of structured and theory-informed curriculum frameworks, particularly across the undergraduate medical education continuum [7,8]. This gap is important because undergraduate education represents an opportunity to establish foundational AI competencies before students enter postgraduate training or professional practice. Early and progressive exposure may help students develop realistic expectations regarding both the capabilities and limitations of AI-supported technologies. For undergraduate medical and dental students, this need is particularly relevant because AI is increasingly incorporated into different stages of the imaging workflow. AI technologies can support image acquisition, protocol optimization, image reconstruction, image enhancement, quality assessment, automated detection, segmentation, quantitative analysis, and workflow management [37, 39]. Future imaging professionals will therefore need more than a general awareness of AI. They should understand how AI systems interact with imaging workflows, how their outputs may influence clinical decisions, and how to recognize situations in which AI performance may be unreliable. Undergraduate education provides an appropriate setting for introducing these competencies progressively and integrating them with existing technical, clinical, and professional education [32, 33].

A comparable educational need exists in dental imaging. Undergraduate Dental students and future dental professionals are increasingly likely to encounter AI-supported technologies in panoramic radiography, intraoral radiography, cephalometric imaging, and cone-beam computed tomography (CBCT) [38,43]. Current applications include automated segmentation, anatomical landmark detection, caries detection, identification of periapical lesions, periodontal assessment, evaluation of bone structures, cephalometric analysis, and treatment planning. Despite these developments, the integration of AI education into undergraduate dental curricula remains less clearly structured, and evidence regarding standardized approaches for teaching AI concepts and their clinical applications is still limited [9,30]. Dental education therefore represents an important area in which foundational AI competencies can be integrated with existing radiographic, diagnostic, and clinical training [6].

Across both medical and dental education, AI competencies should extend beyond knowledge of technological terminology. Students should acquire a basic understanding of datasets, model training and validation, performance metrics, generalizability, and algorithmic limitations, together with the ability to critically appraise AI-generated outputs. They should also recognize potential sources of error, bias, uncertainty, poor data quality, and disparities in system performance [29, 36]. In parallel, responsible AI education should address patient privacy, informed consent, data governance, transparency, explainability, cybersecurity, accountability, regulatory requirements, and professional responsibility [34,42]. These competencies are particularly important in imaging, where AI outputs may influence image interpretation, clinical decision-making, radiation exposure, and patient management.

Despite growing recognition of these educational needs, AI training is still inconsistently integrated into undergraduate medical and dental education. Recent reviews indicate increasing interest in AI education among medical students but also demonstrate substantial variation in curricular integration and a lack of standardized approaches [7,8]. At the same time, universities are beginning to introduce AI-related teaching activities addressing clinical applications, limitations, ethics, and responsible use. These developments suggest a transition from viewing AI solely as a technological tool toward recognizing AI literacy as a broader professional competency for future healthcare practitioners. However, there remains a need for an educational framework specifically adapted to medical and dental imaging that brings together AI fundamentals, clinical imaging applications, image quality, radiation protection, patient safety, critical appraisal, ethics, regulation, and professional practice [18, 20].

Therefore, there is a need for a structured, clinically oriented, and adaptable framework that can integrate AI education into existing undergraduate medical imaging and dental curricula without replacing core clinical and technical education. Such a framework should provide a progressive pathway from basic AI literacy to clinical application, critical evaluation, ethical and regulatory awareness, and human–AI collaboration. Accordingly, this teaching review proposes a 12-module educational framework for undergraduate medical and dental students, with the aim of developing the knowledge, practical understanding, and critical competencies required for the safe, effective, and responsible use of AI-enabled imaging technologies.

II. Aim

The aim of this teaching review is to propose an evidence-informed and adaptable educational framework for integrating artificial intelligence training into undergraduate medical and dental imaging education. The proposed framework aims to:

- Introduce students to the fundamental concepts and terminology of artificial intelligence, machine learning, deep learning, and generative AI.
- Describe the major applications of AI across medical and dental imaging, including image acquisition, reconstruction, enhancement, segmentation, detection, classification, and workflow optimization.
- Develop students' ability to critically evaluate AI-based imaging technologies, including their performance, clinical validity, limitations, generalizability, and potential sources of error and bias.
- Explain the role of AI in image quality optimization, quality assurance, radiation dose optimization, and radiation protection.
- Promote understanding of patient safety, human oversight, clinical judgment, and responsible human–AI collaboration in imaging practice.
- Address the ethical, legal, regulatory, and professional considerations associated with AI, including privacy, informed consent, data governance, transparency, accountability, and algorithmic bias.
- Prepare undergraduate medical imaging and dental students to use and critically engage with AI-enabled technologies safely, effectively, and responsibly in their future professional practice.

III. Materials and Methods

Study Design

This study was designed as a structured educational review and curriculum-development study to identify educational needs, competencies, and clinically relevant applications of artificial intelligence for undergraduate medical and dental imaging education. The main objective was to develop an evidence-informed and adaptable framework for integrating AI training into undergraduate medical and dental imaging curricula.

The study included three main stages: (1) a structured literature search and screening process; (2) thematic synthesis of educational competencies and clinical applications; and (3) development of a proposed undergraduate AI training framework based on the identified competencies.

Literature Search Strategy

The search combined controlled vocabulary and free-text terms related to artificial intelligence, medical and dental imaging, radiology, education, curriculum development, training, and AI literacy. Search terms included "artificial intelligence," "AI," "machine learning," "deep learning," "generative AI," "medical imaging," "dental imaging," "undergraduate education," "curriculum," "AI literacy," "AI competencies," "radiation protection," "radiation dose," "image quality," "patient safety," and "clinical decision support." Boolean operators AND and OR were used according to database requirements. 3 reviewers independently screened studies. Disagreements were resolved by consensus. Studies published between January 2015 and May 2026 were considered for inclusion. Eligible publications included original research articles, clinical studies, systematic reviews, meta-analyses, narrative reviews, professional guidelines, and regulatory documents published in English or French.

The search identified 316 records from PubMed/MEDLINE, Scopus, Web of Science, Google Scholar, and manual reference-list searches. After removing 56 duplicates, 260 records remained for title and abstract screening. Of these, 198 were excluded because they did not meet the eligibility criteria or were insufficiently relevant to AI education, medical or dental imaging, radiation protection, image quality, patient safety, or related educational considerations. A total of 62 reports were assessed through full-text review. Following assessment, 19 publications were excluded because they did not sufficiently address the predefined scope. Therefore, 43 publications were included in the final evidence synthesis. Articles were selected based on their relevance to the application of AI in medical and imaging education. The complete process of identification, screening, full-text assessment, and inclusion is presented in the PRISMA 2020 flow diagram (Figure 2).

Eligibility Criteria

Publications were considered eligible when they addressed one or more of the following areas:

AI education, training, or AI literacy among undergraduate medical imaging, radiography, dental imaging, or undergraduate dental students;
AI competencies and educational needs among medical students, radiology residents, radiographers, dental students, or other relevant imaging professionals;
Curricula, frameworks, recommendations, or educational models for integrating AI into healthcare or imaging education;
AI applications in medical and dental imaging;
AI-assisted image acquisition, reconstruction, enhancement, processing, detection, segmentation, classification, or quantitative analysis;
AI applications in image quality, quality assurance, workflow optimization, and clinical decision support;
AI applications in radiation dose optimization and radiation protection;
Patient safety and human oversight in AI-supported imaging;
Ethical, legal, regulatory, professional, and societal considerations related to AI; and
Competencies required for the safe and responsible use of AI by future imaging professionals.

Studies unrelated to medical or dental imaging or imaging education, or focused exclusively on non-medical AI applications, were excluded.

Assessment of Methodological Quality and Risk of Bias

Because the review included heterogeneous publication types, including educational studies, clinical studies, reviews, guidelines, and regulatory documents, a single risk-of-bias assessment tool was not considered appropriate. The methodological characteristics and potential limitations of the included evidence were therefore considered during the thematic synthesis and interpretation of the findings. Given the primarily educational objective of the review and the heterogeneity of the evidence, no formal pooled effect estimate or quantitative meta-analysis was performed.

Data Synthesis

Because of the substantial heterogeneity of the included publications in terms of study design, educational population, intervention type, imaging modality, clinical application, and reported outcomes, quantitative meta-analysis was not considered appropriate.

A qualitative thematic synthesis was therefore undertaken. Extracted information was organized into predefined educational and clinical themes. Particular attention was given to competencies applicable to undergraduate medical imaging and dental imaging education, including:

fundamental concepts of AI, machine learning, deep learning, and generative AI;
medical and dental imaging data and basic AI workflows;
clinical applications of AI across imaging modalities;
AI-assisted image acquisition, reconstruction, enhancement, and processing;
image segmentation, detection, classification, and quantitative analysis;
image quality assessment and quality assurance;
radiation dose optimization and radiation protection;
critical evaluation of AI-generated outputs;
diagnostic performance and clinical validation;
AI performance metrics and model evaluation;
data quality, bias, generalizability, and system limitations;
patient safety and human oversight;
ethical, legal, regulatory, and professional considerations;
AI-assisted clinical decision-making;
human–AI collaboration and changing professional roles; and
multidisciplinary collaboration and lifelong learning.

The identified themes were subsequently grouped into five overarching educational domains according to their educational relevance, clinical applicability, and progression from foundational AI literacy to clinical, ethical, and professional competencies. These five domains were used to define the learning objectives, competencies, and educational content of the proposed 12-module undergraduate AI curriculum for medical and dental students.

IV. Results

Development of the Proposed Educational Framework

The proposed educational framework was developed through a thematic synthesis of the educational needs and clinically relevant AI applications identified in the literature. The framework was specifically designed for undergraduate medical and dental students, with the intention of introducing AI competencies progressively alongside existing technical, clinical, and professional education. The framework was designed according to a progressive educational approach, beginning with fundamental AI literacy and advancing toward clinical applications, critical evaluation, patient safety, ethical considerations, and future professional practice.

The proposed curriculum consists of 12 AI training lectures/modules, organized into five sequential educational domains:

Domain 1 – Artificial Intelligence and Imaging Foundations

This domain introduces undergraduate students to the fundamental concepts and terminology of AI, machine learning, deep learning, and generative AI. It also introduces the role of data in AI systems and explains the basic relationship between imaging data, algorithms, model development, and clinical applications.

Domain 2 – AI Applications in Medical and Dental Imaging

This domain introduces students to the clinical applications of AI across major medical and dental imaging modalities. Topics include digital radiography, computed tomography (CT), magnetic resonance imaging (MRI), mammography, fluoroscopy, panoramic radiography, intraoral radiography, and cone-beam computed tomography (CBCT).The emphasis is placed on the role of AI in image acquisition, reconstruction, enhancement, segmentation, detection, classification, quantitative analysis, workflow optimization, and clinical decision support.

Domain 3 – Image Quality, Radiation Protection, and Patient Safety

This domain addresses the contribution of AI to image quality optimization, quality assurance, radiation dose optimization, and radiation protection. Students are introduced to the potential use of AI for protocol optimization, image reconstruction, noise reduction, automated quality assessment, and error detection.

Domain 4 – Critical Evaluation, Ethics, and Regulation

This domain develops students' ability to critically evaluate AI-based imaging technologies and their outputs. Students are introduced to fundamental concepts of model performance and validation, including sensitivity, specificity, accuracy, precision, area under the receiver operating characteristic curve, generalizability, and clinical validity. The domain also addresses data quality, algorithmic bias, uncertainty, transparency, explainability, patient privacy, informed consent, data governance, cybersecurity, regulatory requirements, accountability, and professional responsibility.

Domain 5 – Human–AI Collaboration and Future Professional Practice

The final domain focuses on the integration of AI into future medical and dental imaging practice. Students examine human–AI collaboration, changing professional roles, multidisciplinary teamwork, clinical workflow transformation, research opportunities, and lifelong learning. The emphasis is placed on preparing students to work alongside AI technologies while maintaining professional responsibility, clinical judgment, patient-centered care, and appropriate human oversight.

Educational Structure and Curriculum Mapping

The 12 proposed AI training modules were mapped to the five educational domains and corresponding learning outcomes. The curriculum therefore follows a progression from:

AI literacy ? AI and imaging fundamentals ? medical and dental imaging applications ? image quality and radiation protection ? patient safety ? critical evaluation of AI ? ethics and regulation ? human–AI collaboration ? future professional practice (Figure 1).

Figure 1: Educational Structure and Curriculum Mapping

This structure was intended to provide undergraduate medical and dental students with a coherent educational pathway that develops not only knowledge of AI technologies but also the critical, ethical, clinical, and professional competencies required for their responsible use.

Educational Outcomes

The proposed framework was mapped to competencies considered essential for AI-enabled medical and dental imaging practice at the undergraduate level. Upon completion of the proposed AI training modules, undergraduate medical and dental students should be able to:

explain fundamental concepts and terminology related to AI, machine learning, deep learning, and generative AI;
describe the basic relationship between imaging data, AI algorithms, model development, and clinical applications;
identify major AI applications across medical and dental imaging modalities;
describe how AI can support image acquisition, reconstruction, enhancement, segmentation, detection, classification, and workflow optimization;
explain the potential role of AI in image quality improvement, radiation dose optimization, and radiation protection;
interpret basic AI performance measures and understand the principles of clinical validation;
critically evaluate AI-generated imaging outputs and recognize situations in which AI results may be inaccurate or misleading;
identify potential sources of bias, error, uncertainty, poor data quality, and limited generalizability in AI systems;
recognize the importance of human oversight and professional clinical judgment when using AI-assisted imaging technologies;
explain key ethical, legal, regulatory, and professional considerations related to the use of AI in medical and dental imaging;
assess the potential impact of AI on patient safety, clinical workflow, and professional practice; and
demonstrate readiness to engage responsibly with AI-enabled technologies in future medical or dental imaging practice.

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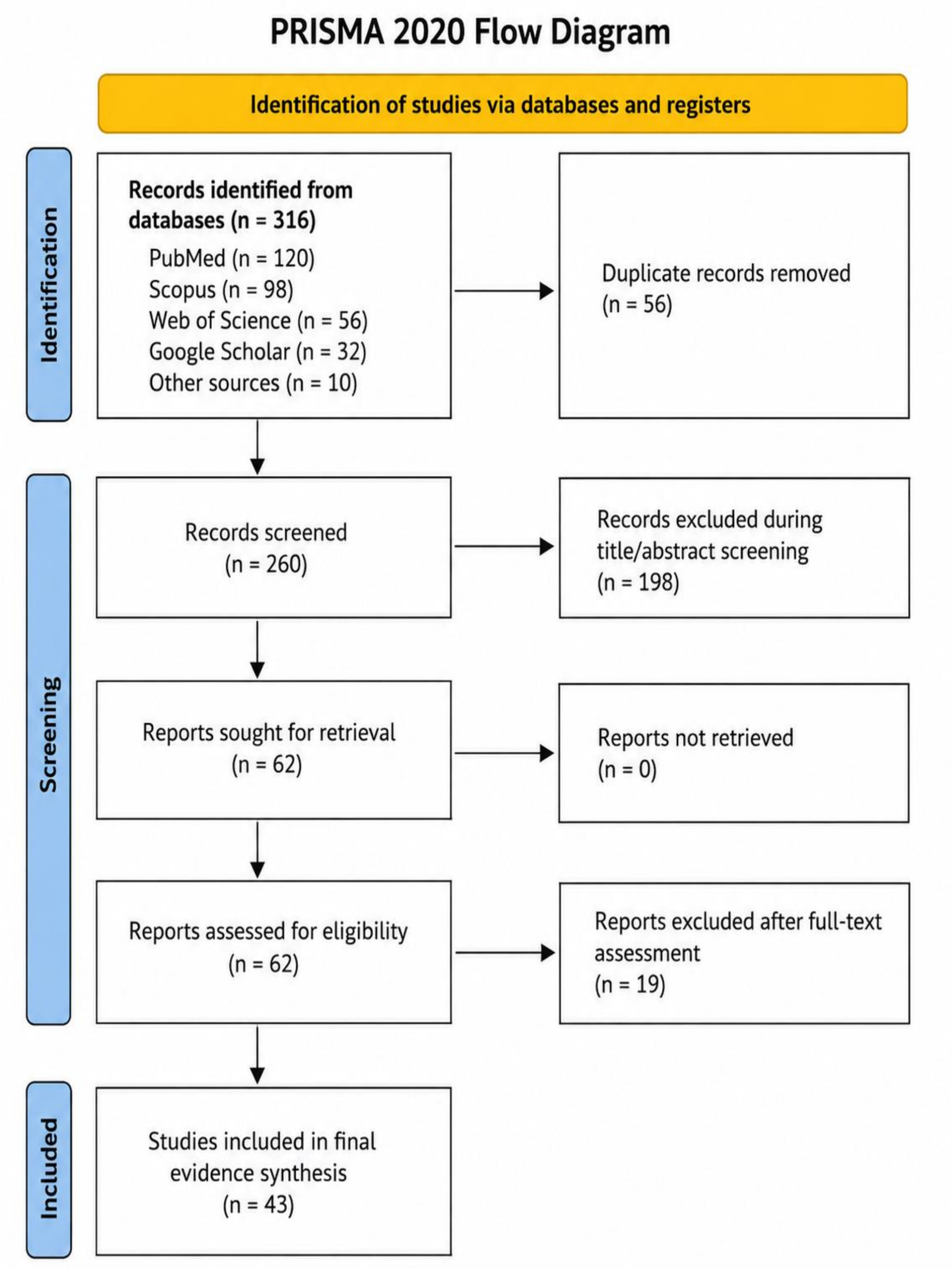

Figure 2 : PRIZMA 2020 flow diagram

AI Curriculum Model for Undergraduate Medical and Dental Imaging Education

Undergraduate medical imaging education should evolve to prepare future professionals for an increasingly AI-enabled clinical environment.The proposed curriculum is designed to develop AI-literate medical imaging professionals who can understand, critically evaluate, safely use, and clinically integrate AI technologies into medical imaging practice (Table 1 and Table 2).

The objective is not to transform medical and dental imaging professionals into AI engineers. Rather, the curriculum aims to provide students with sufficient technical literacy, clinical understanding, ethical awareness, and research skills to work effectively at the interface between medical imaging, artificial intelligence, and patient care.

Expected Learning Outcomes for Undergraduate Medical Students

At the end of the 12-lecture curriculum, undergraduate Medical Students should be able to:

Understand the basic concepts of AI, machine learning, and deep learning in medical imaging.
Describe the main uses of AI in digital radiography and chest imaging.
Explain how AI is used in CT and MRI for image analysis, segmentation, and lesion detection.
Identify the main applications of AI in Maxillo-facial imaging and CBCT.
Describe how AI supports mammography and breast imaging.
Explain the use of AI in fluoroscopy and dynamic imaging.
Understand how AI can help reduce radiation dose and optimize imaging protocols.
Recognize the role of AI in improving image quality and quality control.
Explain how AI can support patient safety and clinical decision-making.
Understand the basic methods used to evaluate the performance of medical imaging AI systems.
Recognize the main ethical, legal, privacy, and bias-related challenges associated with clinical AI.
Discuss the future role of medical imaging professionals and the importance of AI skills in clinical practice.

Module	Topic	Key Learning Objectives
1	**Introduction to Artificial Intelligence in Medical Imaging**	**Define AI, machine learning, and deep learning; neural networks, and convolutional neural networks (CNNs) used for image analysis. understand their basic principles, evolution of AI in radiology; current and emerging applications**
2	**AI in Digital Radiography and Chest Imaging**	**AI-assisted detection of pulmonary abnormalities, nodules, pneumonia, pneumothorax and fractures; clinical workflow**
3	**AI in CT and MRI**	**Automated image analysis, segmentation, lesion detection, image reconstruction, workflow optimization and quantitative imaging**

4	AI in Maxillo-facial Imaging and CBCT	AI-assisted CBCT interpretation, anatomical segmentation, TMJ assessment, mandibular canal detection, implant planning and pathology detection
5	AI in Mammography and Breast Imaging	Screening support, lesion detection, classification, risk assessment and radiologist–AI collaboration
6	AI in Fluoroscopy and Dynamic Imaging	AI-assisted fluoroscopic analysis, motion assessment, procedure optimization and potential applications in VFSS/swallowing examinations
7	AI for Radiation Dose Optimization	Dose prediction, protocol optimization, patient specific imaging parameters, automatic exposure optimization and dose monitoring
8	AI for Image Quality and Quality Assurance	Automated image-quality assessment, artifact detection, reconstruction, protocol verification and quality-control systems
9	AI for Patient Safety and Clinical Decision Support	Risk prediction, error detection, clinical decision support systems, human oversight and AI-assisted safety alerts
10	Evaluation and Clinical Validation of Medical Imaging AI	Sensitivity, specificity, accuracy, ROC-AUC, Dice coefficient, false positives/negatives, bias, generalizability and external validation
11	Ethics, Regulation and Professional Responsibilities in Medical AI	Patient privacy, GDPR, AI bias, transparency, explainability, accountability, EU AI Act, Medical Device Regulation and professional responsibility
12	The Future Role of Medical Imaging Professionals in the AI Era	Changing professional roles, AI-assisted workflow, multidisciplinary collaboration, AI literacy, research opportunities, lifelong learning and future career pathways

Table 1: AI Curriculum Model for Undergraduate Medical Students: 12-Module Curriculum

Module	Topic	Key Learning Objectives
1	Introduction to Artificial Intelligence in Dental Imaging	Define AI, machine learning, and deep learning; neural networks, and convolutional neural networks (CNNs) used for image analysis. understand their basic principles and relevance to dentistry.
2	Fundamentals of Medical and Dental Image Data	Understand digital image formation, image quality, datasets, annotations, and common imaging modalities used in dentistry.
3	AI in Dental Radiographic Image Analysis	Explore AI applications in panoramic, intraoral, cephalometric imaging, including automated image interpretation.
4	AI in Maxillo-facial Imaging: CT, MRI and CBCT	AI-assisted MRI, CT and CBCT interpretation, TMJ assessment, mandibular canal detection, implant planning and pathology detection
5	AI for Detection of Dental Pathologies	Examine AI-assisted detection of dental caries, periapical lesions, periodontal bone loss, impacted teeth, and other abnormalities.
6	AI-Assisted Segmentation and Anatomical Identification	Understand automated segmentation and identification of teeth, anatomical structures, lesions, and landmarks.
7	AI for Radiation Dose Optimization	Dose prediction, protocol optimization, patient specific imaging parameters, automatic exposure optimization and dose monitoring
8	AI for Image Quality and Quality Assurance	Automated image-quality assessment, artifact detection, reconstruction, protocol verification and quality-control systems
9	AI for Patient Safety and Clinical Decision Support	Risk prediction, error detection, clinical decision support systems, human oversight and AI-assisted safety alerts

10	**Evaluation and Clinical Validation of Medical Imaging AI**	**Sensitivity, specificity, accuracy, ROC-AUC, Dice coefficient, false positives/negatives, bias, generalizability and external validation**
11	**Ethics, Regulation and Professional Responsibilities in Medical AI**	**Patient privacy, GDPR, AI bias, transparency, explainability, accountability, EU AI Act, Medical Device Regulation and professional responsibility**
12	**The Future Role of Medical Imaging Professionals in the AI Era**	**Changing professional roles, AI-assisted workflow, multidisciplinary collaboration, AI literacy, research opportunities, lifelong learning and future career pathways**

Table 2: AI Curriculum Model for Undergraduate Dental Students: 12-Module Curriculum

Expected Learning Outcomes for Undergraduate Dental Students

At the end of the 12-lecture curriculum, undergraduate dental students should be able to:

Explain the fundamental concepts of AI, machine learning, and deep learning.
Describe major applications of AI in dental imaging.
Interpret the basic performance measures used to evaluate AI diagnostic systems.
Critically evaluate AI-generated radiographic findings.
Explain the role of AI in personalized imaging and radiation protection.
Recognize the role of AI in improving image quality and quality control.
Explain how AI can support patient safety and clinical decision-making.
Understand the basic methods used to evaluate the performance of dental imaging AI systems.
Recognize the main ethical, legal, privacy, and bias-related challenges associated with clinical AI.
Discuss the future role of dental imaging professionals and the importance of AI skills in clinical practice.

V. Discussion

Artificial intelligence has emerged as a promising tool across different medical imaging modalities, including radiography, computed tomography, magnetic resonance imaging, ultrasound, and dental imaging. AI-based systems can support image acquisition, reconstruction, segmentation, detection of abnormalities, and diagnostic decision-making, potentially improving diagnostic accuracy while reducing interpretation time [26] (Figure 3). In dental radiology, AI may facilitate the detection of caries, periodontal bone loss, periapical lesions, and other pathological findings, while also contributing to more standardized image interpretation. However, further validation using large, diverse datasets and appropriate clinical studies is required before these technologies can be routinely integrated into clinical practice (Table 3). The current revolution is driven by Artificial Intelligence, which is transforming how medical images are acquired, reconstructed, processed, analyzed, interpreted, and integrated into clinical decision-making [23, 24, 25]. The integration of artificial intelligence into personalized imaging represents a promising approach to improving radioprotection by adapting imaging protocols to each patient's individual characteristics, clinical indications, and diagnostic needs. AI can help optimize exposure parameters, enhance image quality, and reduce unnecessary repeat examinations, making personalized imaging an important strategy for achieving an

appropriate balance between diagnostic accuracy and radiation dose [22].
AI is therefore increasingly considered an important component of the modern medical imaging workflow rather than simply an additional image-analysis tool [27, 31].

Previous educational studies have primarily focused on AI training for radiology residents and other postgraduate learners, while structured undergraduate programs remain less developed. The proposed framework extends existing educational approaches by introducing AI competencies progressively, beginning with fundamental AI literacy and continuing toward clinical applications, critical evaluation, patient safety, ethics, regulation, and professional practice[20, 21]. This progression may help students develop a realistic understanding of both the potential and limitations of AI before entering clinical practice [19, 35].

An important feature of the proposed framework is its emphasis on AI literacy rather than AI engineering. Undergraduate students do not necessarily need advanced programming skills; instead, they should understand how AI systems use imaging data, how models are trained and validated, how performance is measured, and why AI outputs may be inaccurate or biased. The proposed curriculum therefore includes concepts such as sensitivity, specificity, accuracy, ROC-AUC, Dice coefficient, generalizability, false-positive and false-negative results, and clinical validation [14, 15].

The framework also emphasizes image quality, radiation protection, and patient safety. AI may support image reconstruction, noise reduction, protocol optimization, automated quality assessment, and radiation dose monitoring. However, dose reduction must always be considered together with diagnostic image quality and clinical requirements. Students should therefore understand that AI can support optimization but does not replace professional responsibility or clinical judgment [16,17].

The separate medical and dental imaging pathways represent another important aspect of the proposed model. Although the fundamental principles of AI are common to both fields, their clinical applications differ. Medical imaging education focuses on modalities such as radiography, CT, MRI, mammography, ultrasound, fluoroscopy, and nuclear medicine, whereas dental imaging places greater emphasis on intraoral radiography, panoramic imaging, cephalometry, and CBCT. The proposed framework therefore allows common AI competencies to be adapted to the specific clinical requirements of each discipline [10, 5].

Critical evaluation and human oversight are essential components of responsible AI education. AI systems may produce false-positive or false-negative findings, and their performance may vary across patient populations, imaging protocols, equipment, and clinical settings. Students should therefore learn to critically assess AI-generated outputs rather than accept them automatically. AI should be presented as a decision-support technology that complements, rather than replaces, professional clinical judgment [11, 12, 13].

Ethical, legal, and regulatory issues are also essential for undergraduate education. Patient privacy, data governance, informed consent, algorithmic bias, transparency, explainability, cybersecurity, accountability, and regulatory requirements should be integrated into AI teaching. These competencies are necessary to ensure that future professionals understand that successful AI implementation depends not only on technical performance but also on patient safety, professional responsibility, and appropriate human oversight.

The proposed 12-module framework should be considered an adaptable educational model rather than a validated intervention. It can be incorporated into existing medical imaging, radiography, dental, CBCT, radiation protection, or clinical education programs according to institutional resources and educational requirements. Future studies should evaluate its feasibility, educational effectiveness, and transferability through prospective implementation and assessment of students' knowledge, skills, attitudes, and critical appraisal abilities.

Overall, this review supports the progressive integration of AI literacy into undergraduate medical and dental imaging education. The proposed framework connects AI fundamentals with clinical imaging applications, image quality, radiation protection, patient safety, critical evaluation, ethics, and future professional practice. Such education may help prepare future imaging professionals to use AI safely, critically, and responsibly while maintaining professional judgment and patient-centered care.

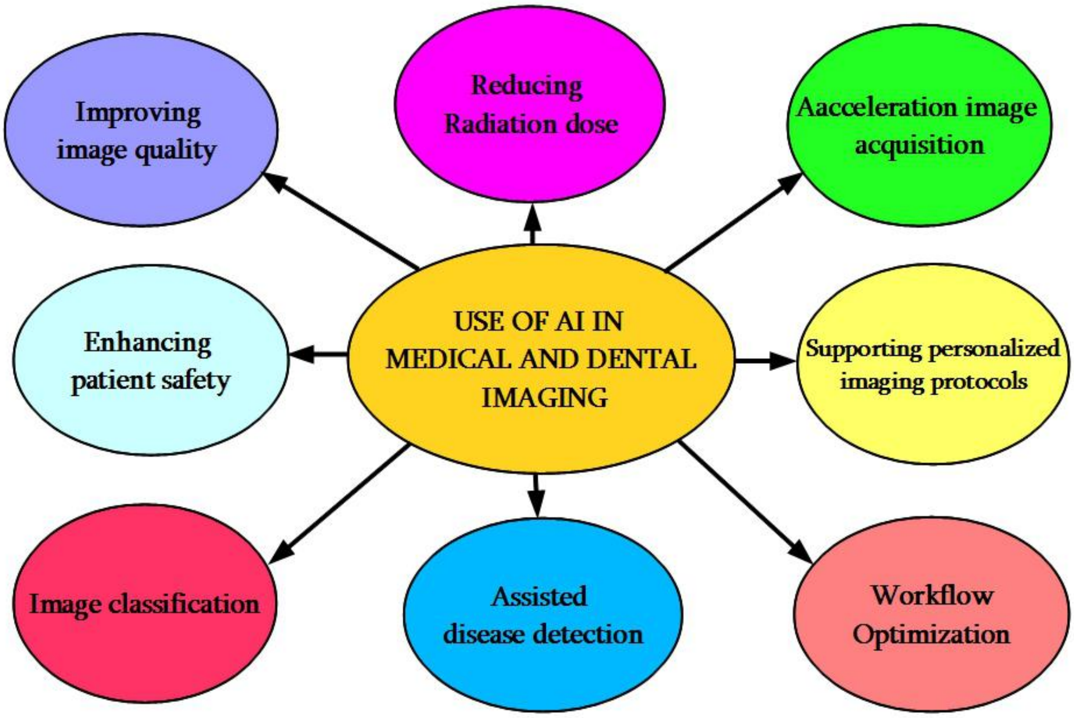

Figure 3: Use of AI in Medical and Dental Imaging

AI Does Not Replace the healthcare professional—It Redefines Professional Identity-However, successful AI implementation depends not only on algorithms but also on healthcare professionals who understand imaging techniques, clinical requirements, and patient-centered care.

Imaging Modality	Main AI Applications	Examples of Clinical Use	Benefits for Patient Care
Digital Radiography (X-ray)	Image quality assessment; automated positioning assistance; pathology detection; workflow optimization; computer-aided diagnosis (CAD)	Detection of pneumonia, pneumothorax, fractures, pulmonary nodules; automated image triage	Faster interpretation; reduction of missed findings; improved workflow efficiency

Computed Tomography (CT)	AI-based reconstruction; noise reduction; artifact correction; automatic protocol optimization; organ and lesion segmentation	Low-dose CT reconstruction; lung nodule detection; stroke imaging; tumor segmentation; automated scan range selection	Reduced radiation dose; improved image quality; faster reconstruction; personalized protocols
Magnetic Resonance Imaging (MRI)	Accelerated acquisition; AI reconstruction; motion correction; image enhancement; automatic segmentation	Faster brain MRI; musculoskeletal imaging; cardiac MRI; tumor volume measurement	Shorter examination time; improved patient comfort; higher-quality images with fewer artifacts
Ultrasound (US)	Real-time image guidance; automated measurements; image interpretation support; quality assessment	Breast lesion classification; fetal measurements; cardiac function assessment; thyroid nodule analysis	Improved reproducibility; assistance for less experienced operators; standardized measurements
Mammography	Computer-aided detection; cancer risk prediction; lesion classification	Breast cancer screening; microcalcification detection; density assessment	Earlier detection; improved screening efficiency; decision support
Nuclear Medicine (PET/SPECT)	Automated segmentation; radiomics; quantitative analysis; disease prediction models	Tumor characterization; metabolic response assessment; PET/CT fusion analysis	More accurate treatment monitoring; personalized oncology pathways
Dental Imaging (CBCT, Panoramic Radiography)	AI segmentation; anatomical landmark detection; implant planning; bone quality assessment	Implant planning; TMJ analysis; airway assessment; pathology detection	Improved surgical planning; reduced interpretation variability; optimized workflow
Fluoroscopy / Interventional Imaging	Procedure guidance; motion analysis; dose monitoring; workflow assistance	Contrast flow analysis; catheter guidance; dose prediction; quality control	Improved procedural safety; reduced radiation exposure; better workflow

Radiotherapy Imaging (CT/MRI/PET)	Automatic segmentation; treatment planning assistance; adaptive radiotherapy	Tumor contouring; organ at-risk delineation; treatment response monitoring	More precise treatment; reduced planning time; personalized therapy
Multimodal Imaging (CT-MRI-PET Fusion)	Image registration; data fusion; predictive modeling; radiomics	Oncology staging; neurological disorders; precision medicine	Comprehensive patient assessment; improved clinical decision support

Table 3. Artificial Intelligence Applications Across Different Medical Imaging Modalities

VI. Future Perspectives

The era of artificial intelligence is rapidly emerging in medical and dental imaging, with AI increasingly transforming image acquisition, reconstruction, image enhancement, automated detection, segmentation, quantitative analysis, radiation dose optimization, and clinical decision support. Countries and healthcare systems are increasingly recognizing this transformation and are developing educational, research, and technological strategies to prepare their healthcare workforce for an AI-enabled clinical environment.

Georgia provides an important example of a country seeking to strengthen its AI research and innovation capacity through international collaboration[40, 41]. Recent EU–Georgia cooperation, including the EU-funded GAIN project, has supported the development of AI research capacity in Georgia through collaboration with leading European institutions such as DFKI in Germany and Inria in France. The project trained Georgian researchers and students, established AI infrastructure, and supported the development of datasets, software, and AI models, including applications in the medical field.

This experience demonstrates that international partnerships can play an important role in accelerating AI capacity building in emerging research environments. For medical and dental imaging, similar EU–Georgia collaborations could provide opportunities for joint research, development of medical imaging datasets, AI-based CBCT and radiography research, radiation-dose optimization, image-quality assessment, clinical validation of AI systems, and development of AI-oriented educational programs.

From an educational perspective, Georgia could use these international partnerships to strengthen AI competencies among future radiographers, radiologists, dentists, and other medical imaging professionals. Collaboration with European universities and research institutions could facilitate joint training programs, student mobility, summer schools, research fellowships, shared datasets, and multidisciplinary projects linking medical imaging, dentistry, artificial intelligence, radiation protection, and patient safety. For the future, integrating AI education into medical and dental imaging curricula could become an important component of this collaboration. Preparing AI-literate medical imaging professionals in Georgia, aligned with European educational and professional developments, may contribute to the responsible adoption of AI while supporting research capacity, innovation, radiation protection, and patient-centred care.

VII. Limitations

This review has several limitations. First, the included literature was heterogeneous in terms of study design, population, educational context, and imaging modality, which limited direct comparison across studies. Second, although multiple databases and manual reference-list screening were used, the search may not have identified all relevant publications, particularly recently developed educational initiatives that may not yet be indexed. Third, the review included different types of evidence, including educational studies, clinical research, reviews, guidelines, and regulatory documents; therefore, the strength and methodological quality of the evidence varied. A formal quantitative risk-of-bias assessment was not performed because the primary purpose of the review was educational framework development rather than estimation of intervention effects. Finally, the proposed curriculum has not yet been prospectively implemented or evaluated in undergraduate students. Its educational effectiveness, feasibility, acceptability, and transferability therefore require validation in future studies.

VIII. Conclusion

Artificial intelligence is rapidly becoming an important component of medical and dental imaging, with applications ranging from image acquisition and reconstruction to image analysis, radiation dose optimization, quality assurance, and clinical decision support. However, the effective and responsible integration of AI into clinical practice requires healthcare professionals who possess not only technical knowledge but also critical, ethical, and clinical competencies. AI education should not be an isolated technical subject; it should be progressively integrated into undergraduate medical and dental imaging education.

This study proposed a structured and adaptable 12-module educational framework for integrating AI training into undergraduate medical and dental imaging education. The framework progresses from fundamental AI literacy and imaging applications to image quality, radiation protection, patient safety, critical evaluation, ethics, regulation, and human–AI collaboration. By introducing these competencies at the undergraduate level, students can develop an early understanding of both the potential and limitations of AI before entering clinical practice.

Accordingly, this article proposes an educational framework for integrating Artificial Intelligence Training Modules into undergraduate medical and dental imaging education. The proposed framework emphasizes that AI should complement, rather than replace, professional clinical judgment and patient-centered care. Future implementation should include practical learning activities and evaluation of students' knowledge, skills, and attitudes, as well as validation of the framework across different educational settings. Ultimately, integrating AI education into undergraduate medical and dental imaging curricula may help prepare future imaging professionals to use AI safely, critically, and responsibly in an increasingly AI-enabled healthcare environment.

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