STUDIA UBB PSYCHOL.-PAED., LXX, 2, 2025, p. 193-226
(Recommended Citation)
DOI:10.24193/subbpsyped.2025.2.09

Integrating the *ASSURE* Instructional Design Model in the Medical Education System: Applications in the Anatomy Discipline

Dan Alexandru SZABO[1*], Ioan Alexandru BALMOS[2], Cristina VERES[3], Roxana Silvia TRUȚA[4], Tiberiu CONSTANTIN[1], Cosmina-Dumitrița LĂU-ANDRIEȘ[1], Heidrun ADUMITRACHIOAIE[5]

ABSTRACT. The ASSURE model is a methodical framework that incorporates the study of learner characteristics, educational objectives, technology integration, resource selection and use, active student engagement, and ongoing evaluation. The article's primary goal is to analyse the ASSURE model's suitability for medical education, with particular emphasis on anatomy instruction. This method highlights the benefits of individualised, interactive, and student-centered learning while offering a comprehensive viewpoint on the ASSURE model's potential in medical education. The initiative enhances the teaching process by investigating these facets. The concept establishes a standard for integrating cutting-edge technology into medical education, transforming anatomy instruction into a dynamic, engaging, and student-centered process. This method facilitates the production of skilled workers who can adapt to the demands of the contemporary healthcare system.

Keywords: The ASSURE model, instructional design, innovative learning, anatomy.

[1] Department of Human Movement Sciences, George Emil Palade University of Medicine, Pharmacy, Science, and Technology, Targu Mures, Romania
[2] Department of Anatomy, George Emil Palade University of Medicine, Pharmacy, Science, and Technology, Targu Mures, Romania
[3] Department of Industrial Engineering and Management, George Emil Palade University of Medicine, Pharmacy, Science, and Technology, Targu Mures, Romania
[4] Department of Law and Public Administration, Faculty of Economics and Law, George Emil Palade University of Medicine, Pharmacy, Science and Technology, Targu Mures, Romania
[5] Department of Pediatrics George Emil Palade University of Medicine, Pharmacy, Science, and Technology, Targu Mures, Romania
* Corresponding author: alexandru.szabo@umfst.ro

INTRODUCTION

Undergraduate practicum training for students enrolled in Special Education programs provides opportunities to develop the competencies needed for a range of specialized professions they may pursue after graduation or through postgraduate and in-service preparation, including special education teacher, speech and language therapist, special educator, support teacher, and educational counsellor. As students enter their practicum experience, they are guided by specific strategies, techniques, and approaches that blend theoretical learning with practical, hands-on engagement. Among these, reflection-based strategies hold particular importance because they deepen students' understanding of what to observe, how to focus their professional growth, and how to interpret their emerging sense of professional identity and responsibility. The reflective practices integrated into the practicum include reflective writing - linked to self-awareness and personal development as students articulate their thoughts and emotions while exploring personal limits (Wright, 2018); reflective thinking - centered on relating, experimenting, exploring, and connecting theoretical knowledge with practical experience (Hathazi & Serban, 2022; Helyer, 2015); reflective logs - used to document the reflection process; and active listening, complemented by individual or group mentoring sessions. Throughout their practicum and mentoring activities, students are encouraged to develop the skills necessary for assessing and supporting children with disabilities. In doing so, they learn to address questions such as: How do I begin? What should I focus on first? What is happening in this context? Is this approach appropriate? Is behavior a form of communication? How does the child learn? How can I better understand and respond to the child's needs and interests?

The practicum aims to cultivate students' professional responsibilities through targeted assignments and objectives, including building strong mentor relationships, reflecting on teaching, producing documents and resources, observing communication with families, participating in the professional community, and engaging in ongoing professional development (Machost & Stains, 2023). Through the implementation of reflective strategies, all parties involved contribute to the development of reflective practitioners - individuals who critically examine, reorganize, and reconsider their planning, observations, and interpretations. As students strengthen their reflective abilities, they learn to integrate others' perspectives into their own practice and experience (Tyler, Boldi, & Cherubini, 2022). For teachers and mentors, this process involves drawing on their expertise to understand how students learn and communicate, fostering the trust and openness needed to build a supportive mentoring relationship.

Reflective thinking in practicum training

Reflective thinking represents a foundational approach within teacher education programs, functioning as a key mechanism for supporting professional development during practicum training. Early conceptualizations of reflective practice, particularly those advanced by John Dewey (1933), established the groundwork for understanding the qualities and dispositions of reflective professionals. Within educational contexts, the primary goal of reflective practice is to foster teachers' capacity to reason about their instructional decisions - why particular strategies are chosen and how teaching can be refined to positively influence student learning outcomes (Lee, 2005). In parallel, the practicum serves as a structured bridge between theory and practice, offering student teachers regular, supervised opportunities to apply and evaluate their knowledge, skills, and attitudes within authentic school environments (Ryan, Toohey, & Hughes, 1996). Building on this perspective, Damon (1992) contends that the practicum's central purpose is to surface problems and issues that prompt the exploration of relevant theories and professional knowledge, positioning practice itself as the organizing core of the curriculum.

Reflective thinking enables student teachers to critically examine experiences through the lens of their evolving understandings, thereby maximizing learning in real-world contexts. Practicum training thus encourages them to apply theoretical principles and pedagogical skills, progressively developing competencies through diverse classroom experiences and gaining insight into the realities of professional practice. This process allows student teachers to assess their readiness for a teaching career, evaluate their improvement, and identify topics requiring further personal or professional development (Ryan, Toohey, & Hughes, 1996).

A recurring theme in the literature concerns the shifting perceptions of preparedness that student teachers experience as they progress through practicum and internship placements. While many preservice teachers initially feel confident due to prior coursework or general exposure to educational theories, the feedback they provide at the conclusion of their training often reveals a more nuanced and self-critical perspective. This shift highlights a growing awareness of the complexities inherent in teaching environments, including the dynamics of teacher–student relationships, the diverse needs of children, and the challenges of managing difficult behaviors. Such developments suggest that the practical realities encountered during fieldwork often expose gaps that are not evident in theoretical preparation alone. The emotionally charged nature of unfamiliar experiences further contributes to a decrease in perceived readiness. Whereas theoretical study may instill a sense of readiness, the practical application

of this knowledge frequently reveals educational challenges and situational nuances that theory alone cannot fully address. The heightened expectations associated with meeting diverse learners' needs during the internship may also contribute to reduced confidence. If this is the case, it should not be interpreted as regression. Instead, it reflects the emergence of deeper critical self-awareness. Li et al. (2025) argue that teacher education programs must support more effectively the transition from theory to practice by providing structured mentorship and sustained opportunities for self-growth as preservice teachers move from academic understanding to professional application. Practicum programs are therefore encouraged to cultivate reflective and critical thinking, enabling student teachers to evaluate their performance and actively pursue continuous improvement. In this sense, Tripp and Rich (2012) conceptualize reflection as a critical, analytical process through which teachers assess the effects of their instructional resolutions within specific contexts to enhance practice. Similarly, Ryan (2013) views reflection as an effort to understand experience concerning oneself, others, and environmental conditions, while reimagining and shaping expectations for personal and collective purposes.

Research consistently stresses the significance of reflection, self-worth, and training in classroom organization as integral components of teacher education (Harlin, 2014; Kong, 2010; Yuksel, 2014). For instance, Kong (2010) examined the effects of a video system on student teachers' capacity for self-reflection and found that video browsing yielded more extensive and deeper reflective notes, particularly in areas such as classroom management and professional teaching knowledge. These enhanced reflections also provided a strong foundation for meaningful professional dialogue with mentors. Complementary studies further demonstrate a positive connection among teachers' self-reflection, coursework in organizational teaching issues, and their sense of self-value (Bullock, Coplan, & Bosacki, 2015; Patterson & Seabrookes-Blackmore, 2017).

More recent research further advances understanding of how reflective practice can be deliberately fostered within teacher education. Minott (2025) proposes the Reflective Approach to Teaching Practicum Debriefing (RATPD), a structured and cognitively informed framework intended to scaffold student teachers' reflective processes and strengthen the connection between educational theory and the lived complexities of classroom teaching. Reflective teaching usually employs the following cognitive dimensions: the capacity to identify, explain, and critically evaluate teaching episodes as a basis for future improvement; the use of self-directed inquiry and critical thinking to build context-sensitive professional knowledge; and the ability to challenge assumptions, explore multiple courses of action, engage in higher-order thinking, and reflect consciously on self-learning. Equally important in this process is how teachers draw on

personal experience, ethical considerations, and professional judgment to make sense of their practice.

Reflective teaching is also understood as a social and collaborative endeavor. It requires openness to sharing ideas, exchanging feedback, and engaging in collective dialogue, as well as the capacity to navigate uncertainties related to personal teaching beliefs and perceptions of competence. These perspectives position reflective thinking not merely as an individual cognitive exercise but as a socially situated, dialogic, and structured process that plays a central role in shaping teachers' emerging professional identities.

A critical dimension of practicum training involves supporting student teachers to translate theoretical knowledge of reflection into practical, actionable processes (Resch & Schrittesser, 2021). Wong (2016) emphasizes that reflection enhances learning by shaping how students perceive and make meaning from practicum experiences. He observes that challenges - such as self-doubt, questions about identity, or daily struggles - often generate insights and deeper reflection, allowing student teachers to articulate and interpret their experiences for professional and personal growth. By critically examining these emotional and pedagogical challenges, student teachers deepen their self-knowledge and develop resilience toward the inherent complexities of teaching. Mentors play a vital role in helping student teachers process these challenges. By situating reflective discussions within the broader school community, mentors offer support in contextualizing experiences and alignment with professional norms and expectations.

Finally, the effectiveness of practicum training is strengthened when teachers and mentors share responsibility with student teachers and collaborate to build trusting relationships (Corrigan & Chapman, 2008). Teachers must strive to be trustworthy professionals (Trelstad, 2008), creating safe and supportive learning environments in which student teachers feel encouraged to engage in reflective dialogue and openly explore their developing practices. A trusting, collaborative environment thus forms the foundation for meaningful reflection, enabling student teachers to explore, express, and refine their emerging professional identities.

Reflective learning strategies used in practicum training

Reflective practice is conceptualized as a continuous, participatory process that enhances the quality of teacher education experiences (Machost & Stains, 2023; Mohamed et al., 2022). It typically involves an iterative cycle comprising reflection, planning for future action, acting, and evaluating outcomes, thus

embedding elements of problem solving, action orientation, and critical inquiry (Mohamed et al., 2022). A substantial body of research demonstrates that reflective practice has the potential to strengthen critical thinking and decision-making processes (Baporikar, 2021; Wilson et al., 2022), particularly when grounded in real professional experiences. Its significance also lies in its capacity to foster learning, growth, and ongoing professional development (Friedland, 2015; Harvey & Vlachopoulos, 2020; Zwozdiak-Myers, 2018).

Within teacher professional development, reflective practice is regarded as an essential component of effective training programs. It enables teachers to critically evaluate their instructional strategies and align their educational choices with students' needs (Borko, 2004). Studies on comprehensive professional development initiatives further suggest that the integration of reflective practice enhances teachers' subject knowledge and reinforces their ability to manage diverse classroom contexts (Garet et al., 2001). Recent trends highlight an increasing emphasis on technology-enhanced learning and collaborative professional communities, both of which complement reflective practice by encouraging teachers to initiate thoughtful dialogue about education and scrutinize their approaches to classroom management.

From the perspective of student teacher education, reflective practice is critical for training aspiring educators with the knowledge, skills, and dispositions required for effective teaching. The transition from student teacher status to beginner teacher status is frequently marked by challenges related to behavior management, building relations with the learners, planning the activities and the transition between them, and support learner diversity. Given the complexities of early career teaching, it is argued that reflective practices during this transition must be intentional and targeted (Nuraeni & Heryatun, 2021). Reflective practice for student teachers typically includes recollection of experiences, exercising reflection while conducting an activity, making a reflection in retrospect of the teaching activity, and participating in mentoring or peer discussion processes that facilitate the construction of personal theories of teaching (Nuraeni & Heryatun, 2021).

However, research indicates that student teachers often encounter difficulties in relating their reflections to theoretical frameworks. Many tend to focus on identifying problems or describing instructional processes without recognizing the theoretical underpinnings of their actions or the implications for curriculum development. As a result, they may not demonstrate sustained critical reflection (Matengu et al., 2021; Jones & Ryan, 2014). Structured reflective activities, including journaling, feedback sessions, and coursework-linked reflection tasks, have been shown to nurture self-awareness and professional development (Harford & MacRuairc, 2008; Malicay, 2023). These practices support pre-service

teachers in scrutinizing the values, beliefs, and attitudes they bring to teaching (Anand & Gangmei, 2023), thereby contributing to the integration of theory and practice.

To promote deeper reflection, practicum training should incorporate strategies that expose student teachers to new ideas and encourage them to translate theory into innovative pedagogical approaches (White, 2009). Enhancing instructional competencies - such as classroom management, teaching strategies, and student engagement - allows teachers to put theoretical concepts in educational environments, thereby strengthening their understanding of teaching in authentic contexts (Anand & Gangmei, 2023; Malicay, 2023). Given that teaching and learning processes are interdependent, mentorship and tutoring sessions should be designed to support reflective engagement. Effective mentoring practices include asking purposeful questions, prompting student teachers to articulate experiences in relation to theory, modelling complex reflective thinking, guiding decision making about classroom practices, creating meaningful assessments, and emphasizing individual contributions (Szabo & Schwartz, 2011; Hibbard et al., 2010; Means et al., 2010).

Li (2025) identifies tutorial sessions and reflective journals as strategies for examining the impact of reflective practice on pedagogical skill development, professional competence, and readiness to navigate diverse educational settings. The findings suggest that tutoring experiences contribute to greater teaching competence, increased responsibility, and the development of teacher identities. These results align with studies demonstrating that reflective practice and mentoring support a deeper understanding of educational practices (Winchester & Winchester, 2014; Massey & Lewis, 2011) and foster professional identity formation (Pillen et al., 2013; Trent, 2010; Findlay, 2006).

Reflective strategies have a central role in practicum training programs aimed at cultivating autonomous, reflective practitioners. Its development is reinforced through structured activities such as reflective teaching journals and the gathering of peer or student feedback, which help pre-service teachers acquire critical teaching competencies. Mentors must therefore provide explicit guidance to highlight that reflective activities are focused and aligned with professional development goals. One influential framework in this regard is the three-part reflective framework (Loughran, 2002; Freese, 1999), which involves anticipatory reflection (planning and reasoning before teaching), contemporaneous reflection (decision making while teaching), and retrospective reflection (post-lesson analysis). This framework structures mentor–student teacher interactions by promoting open discussion, encouraging questioning, fostering observation of real-time decision making, and engaging in shared post-lesson reflection.

Collaborative work is also underscored as essential within practicum contexts, as it contributes significantly to the development of professional competence (Lozano Cabezas et al., 2022; Raduan & Na, 2020). Collaborative reflection enables student teachers to embed reflective attitudes into their ongoing academic and professional growth (Bas, 2022) and to sustain such practices even in the absence of explicit role models. Collaborative reflection sessions additionally cultivate a shared learning culture and strengthen professional development communities (Li, 2025).

Reflective logs as purposeful instruments in practicum training

Reflective logs are generally understood as written tasks that require learners to articulate and analyze their experiences through reflective thinking (Moon, 2004). Their use is well established across practice-based learning environments, including teacher education (Korthagen, 2011). The primary function of reflective logs is to cultivate students' critical and reflective thinking by encouraging systematic attention to how they analyze their own actions, recognize their development, and formulate future goals (Lee & Gyogi, 2016). According to Moon (2004), the reflective process that structures these logs typically unfolds in a series of stages: description and timeline establishment, integration of additional ideas, reflective analysis through observations or questions, deeper processing such as generating or testing new interpretations, and the eventual production of the written account.

Within teacher education practicum settings, reflective logs serve as a mechanism for student teachers to assess their learning, identify difficulties, and consider strategies for improvement. They also provide space for examining and potentially reshaping pre-existing beliefs and assumptions. Although reflective logs have limitations - such as variable depth of reflection and reliance on students' willingness to be candid - Lee and Gyogi (2016) emphasize that they nonetheless offer access to learners' perspectives that might otherwise remain inaccessible to instructors. For mentors and practicum coordinators, these logs function as diagnostic tools that reveal students' understanding, progress, and challenges, thereby enabling personalized and timely feedback.

Research further demonstrates that reflective logs contribute to the development of complex, often interdisciplinary competencies, such as deep information processing (Temple, 2001). They support awareness of professional dispositions, values, and knowledge, which are foundational in teacher preparation. Moreover, reflective writing helps student teachers interpret emotional and behavioral responses and to recognize the personal significance of their practicum experiences. Effective integration of reflective logs into practicum programs

therefore requires deliberate instructional design, including explicit planning of reflective activities, structured opportunities for reflection before, during, and after practicum events, and the creation of an institutional culture that values reflective practice (Eyler, Giles, & Schmiede, 1996).

Reflective logs may be implemented in diverse formats, from printed templates to digital platforms such as online blogs. Their content can include standard or context-specific questions, commentary on selected behaviors or incidents, descriptions from the perspective of an external observer, or open-ended reflections blending accounts of observed activities with personal insights (Trif & Popescu, 2013). Online platforms additionally allow instructors to regulate submission timelines by controlling the opening and closing of entries, thereby ensuring continuous engagement - a key element in developing reflective capacity (Dyment & O'Connell, 2010). Although Lucas and Fleming (2012) didn't find differences in the quality or depth of reflection among online and paper journals, students often expressed a preference for hard-copy formats.

Given that reflective writing is not an intuitive skill for most novice teachers (Epp, 2008; Spalding & Wilson, 2002), explicit instruction is essential for meaningful engagement in reflective learning (Munchy, 2014). Studies show that targeted training can substantially enhance students' perceived ability to reflect (McInnis-Bowers, Chew, & Bowers, 2010). Such training may include familiarizing students with the format of logs, clarifying the purpose of reflective writing so that both the "how" and the "why" are understood (Sharma, 2010), modelling reflective thinking through examples and structured assignments with gradually reduced scaffolding (Dyment & O'Connell, 2010), and articulating clear assessment criteria, as students often express uncertainty about evaluative expectations (McGarr & Moody, 2010).

DISCUSSION AND CONCLUSION

Practicum training in Special Education represents a critical formative space in which theoretical knowledge, practical experience, and professional identity intersect. This review highlights the central role of reflective strategies and instruments in mediating this intersection, demonstrating that reflective practice - whether expressed through reflective thinking, guided dialogue, or structured writing - serves as the conceptual and pedagogical core of practicum learning. Across literature, reflective engagement emerges as both a cognitive and relational process: it enables student teachers to interpret their instructional decisions, confront the complexities of real educational environments, and cultivate the dispositions of autonomous, ethically

grounded practitioners. Through structured cycles of observation, analysis, and action, students develop deeper awareness of their strengths, limitations, and evolving professional responsibilities.

The reviewed studies consistently affirm that reflection is indispensable for supporting the transition from theoretical preparation to situated professional practice. Practicum experiences frequently disrupt initial confidence, revealing gaps between academic knowledge and the nuanced realities of working with children with diverse communication, behavioral, and learning needs. Rather than signaling inadequacy, these shifts indicate the emergence of critical self-awareness and the internalization of professional standards. Reflective strategies - particularly those embedded in mentoring, feedback discussions, and collaborative learning communities - help student teachers make sense of challenges, contextualize them within broader educational principles, and generate informed pathways for improvement.

Equally, instruments such as reflective logs provide essential scaffolding for translating experiential learning into purposeful professional growth. When integrated intentionally into practicum programs, logs function as diagnostic, developmental, and metacognitive tools that deepen students' analytical capacities and support mentors in tailoring guidance. The literature stresses that reflective writing is not innate; thus, explicit instruction, modelled examples, and clear evaluative criteria are necessary to cultivate meaningful engagement and sustained reflective habits.

Taken together, the evidence suggests that practicum training is most effective when reflective strategies are deliberately embedded, systematically supported, and collaboratively enacted. By fostering environments characterized by trust, dialogue, and critical inquiry, teacher education programs can strengthen the development of reflective practitioners - professionals capable of navigating complexity, responding thoughtfully to learners' needs, and continually refining their educational expertise.

Introduction

Contemporary medical education is undergoing a complete transformation, driven by rapidly advancing technology and the demands of an increasingly diverse academic environment. Adapting to these changes is imperative, as it presents an opportunity to reconfigure traditional teaching methods and transform them into a dynamic, student-centred process. Instructional design models, such as ASSURE, are essential for organising a structured, interactive, practical educational process (Abuhassna & Alnawajha, 2023).

The ASSURE model is a systematic framework that integrates learner-characteristics analysis, setting instructional objectives, selecting and using instructional materials and technologies, active student participation, and continuous assessment. The model presented supports the development of a personalised learning environment in which diverse learning styles and individual needs are recognised and valued. By utilising emerging technologies, such as augmented reality (AR), virtual reality (VR), and 3D simulations, medical education can provide students with immersive experiences that facilitate deep learning and application of theoretical knowledge (Bernard, 2023; Abuhassna & Alnawajha, 2023).

These technologies are intended to increase student motivation and engagement and improve academic performance by promoting active learning (Parvu et al., 2023a; Parvu et al., 2023b). For example, exploring anatomical structures through AR and VR simulations provides students with a three-dimensional perspective on the human body, facilitating understanding of spatial relationships and their functions (Pottle, 2019). At the same time, tailoring teaching to individual learning styles helps create a more effective and adaptive educational process (Luchs, 2023).

This paper explores the relevance of the ASSURE model in medical education, with a particular focus on anatomy, highlighting how each stage of this model can contribute to a more structured, engaging, and relevant learning process for future healthcare professionals.

Aim of the paper

The paper's main aim is *to analyse the applicability of the ASSURE model in medical education, with a focus on anatomy teaching.* By examining each stage of the model, the paper aims to highlight the following aspects:

· Personalisation of the educational process: How can analysing learner characteristics support the development of teaching methods tailored to individual needs and learning styles?

· Integration of modern technologies: The added value of tools such as AR, VR, and 3D simulations in anatomy learning, encouraging applied and collaborative learning.

· Continuous assessment and feedback: Constant assessment of student progress can help optimise the educational process and improve academic performance.

· Bridging theory and practice: facilitating the transition from theoretical knowledge to its application in clinical situations through simulations and interactive scenarios.

This approach provides an integrated perspective on the potential of the ASSURE model in medical education, highlighting the advantages of tailored, interactive, and student-centered instruction. By exploring these aspects, the project contributes to improving the educational process.

1. Instructional Design Models: Background and Current Trends

The general principles of instructional design are:

· Learner-centredness: tailoring materials to individual needs and learning styles (Abuhassna & Alnawajha, 2023).

· Clarity of objectives: formulating specific, measurable outcomes. Defining learning objectives is central to any instructional design. In medical education, objectives need to be precise, e.g., 'Identify the anatomical structures of the central nervous system (North et al. 2021).

· Logical structuring of content: progressive and coherent organisation. Materials should be organised to support the gradual accumulation of knowledge, moving from simple to complex concepts (Luchs, 2023).

· Interactive activities: active involvement of learners to reinforce learning. Active learning (e.g., by solving clinical cases or practical activities) stimulates critical thinking and application of knowledge (Luchs, 2023).

· Constant feedback: providing information about progress for adjustment and motivation. Models should accommodate adjustments to students' needs and feedback to improve subsequent lessons (Abuhassna & Alnawajha, 2023).

· Continuous evaluation: measuring the effectiveness of materials and methods. Assessment should be integrated into the learning process to provide helpful feedback and adapt teaching strategies (Luchs C. 2023).

1.1. The context of instructional design

Instructional design has evolved in response to the need to structure the educational process systematically. Its role has become more critical in the current context, characterised by digitisation and rapid access to information. This field's main premises are (Abuhassna & Alnawajha, 2023).

1.1.1. Learner-orientation (Abuhassna, H., & Alnawajha, S. 2023)

1.1.2. Personalisation of learning and active student involvement: Modern education emphasises the personalisation of learning and active participation of learners and students. Instructional design models help to create materials that respond to individual needs and different learning styles. (Abuhassna, H., & Alnawajha, S. 2023)

1.1.3. Educational Technology Integrating digital tools such as e-learning platforms and multimedia resources is a dominant trend. Medical education facilitates the use of virtual simulations and interactive resources, providing students with more authentic learning experiences (Abuhassna & Alnawajha, 2023).

1.1.4. Need for evidence-based design: Instructional design models are founded on learning theories such as behaviourism, constructivism, and cognitive theory. They provide a scientific framework for designing lessons, materials, and activities. (Abuhassna & Alnawajha, 2023)

Some instructional design models are:

1.2. The ADDIE instructional model is a framework used for developing instructional materials and instruction that is qualitative and effective. The model's name is an acronym and stands for (Patel, S. R. et al. 2018)

· *Analysis*: This stage focuses on identifying learning needs, objectives, instructional problems, content, and context of instruction (Jabaay, 2020).

· *Design:* A detailed plan of the instruction is made, taking into account the learning objectives, teaching strategies, materials needed, and assessment methods (Jabaay et al. 2020).

· *Development:* In this stage, the necessary materials and resources are produced for further use. These materials may include manuals, photo- and video-based presentations, or interactive applications (Li & Cheong, 2023).

· *Implementation:* is the stage where the instructional methods are put into practice (Aydin SO. et al. 2023).

· *Evaluation:* It is the last stage of the model and focuses on analysing the effectiveness of the instructional model through evaluations during and at the end of the sessions (Patel et al. 2018).

1.3. The ASSURE instructional model is put into practice using the following steps:

· Analyse learners: identify participant characteristics, such as age, gender, knowledge level, learning style, and access to resources (Weller et al. 2015).

· State objectives: Set learning objectives that establish what participants should know as a result of the lesson (Weller et al. 2015).

· Select methods, media, and materials: Choosing the most appropriate educational tools and supporting materials (Weller et al. 2015).

· Use methods, media, and materials: Planning how these resources will be integrated (Khene et al. 2021).

· Require learners' participation: Actively involve learners through interactive and applied activities (Khene et al. 2021).

· Evaluate and revise: Evaluate the effectiveness of the educational process through constant feedback for future improvement (Khene et al. 2021).

1.4. Gagne's instructional model is based on nine steps, based on psychological and pedagogical principles. These steps are as follows: capturing attention, informing about objectives, stimulating recall of prior knowledge, presenting material, guiding learning, eliciting performance, providing feedback, evaluating performance, and creating retention and transfer. (Miner et al. 2015)

1.5. Current Trends in Instructional Design

In recent years, instructional design has been influenced by several major trends:

1.5.1. Technology-based learning

a.Medical simulators and virtual reality (VR) are used to recreate complex clinical scenarios.

b.Online platforms allow access to asynchronous courses, facilitating distance learning. (Miner, A. et al. 2015)

1.5.2. Gamification

Game elements are integrated into the educational process to increase student motivation and facilitate hands-on learning. (Espada-Chavarria et al. 2023)

1.5.3. Microlearning

This trend involves fragmenting content into small, accessible, and easily digestible modules, which is well-suited to intensive medical education.

1.5.4. Personalised learning (Luchs, 2023)

Using artificial intelligence, courses can be tailored to each student's specific needs. (Luchs C. 2023)

1.5.5. Interdisciplinary approach

Instructional design in medical education integrates content from multiple disciplines (biology, technology, and ethics) to provide a holistic perspective. (Espada-Chavarria et al. 2023)

In conclusion, modern education's instructional design models provide a well-defined framework for organising and delivering educational content. In medical education, current trends, such as the use of technology and active learning methods, contribute to the training of better-trained specialists.

The following chapter will explore the specific applicability of the ASSURE model, demonstrating how it can be utilised in anatomy teaching.

2. Overview of the ASSURE model

Teachers use the ASSURE model to design and implement practical lessons, tailoring learning materials and methods to students' needs. The model's steps are designed to maximise learner engagement and ensure active, practical learning. It is structured into six stages; each stage is essential for providing effective instruction tailored to learners' needs (Byrne et al., 2022).

The ASSURE model provides a flexible framework applicable across various educational contexts, contributing to the continuous improvement of teaching and learning. Using this model, teachers can create a compelling and innovative information system (Shah, 2020).

Detailed description of each stage in the ASSURE model:

2.1. Analyse learners' characteristics

In this stage, the characteristics of the target group of learners are analysed to understand their educational needs, learning styles, and level of preparedness. This analysis is necessary for lesson personalisation and when choosing the most appropriate learning methods (Figure 1) (Byrne et al., 2022).

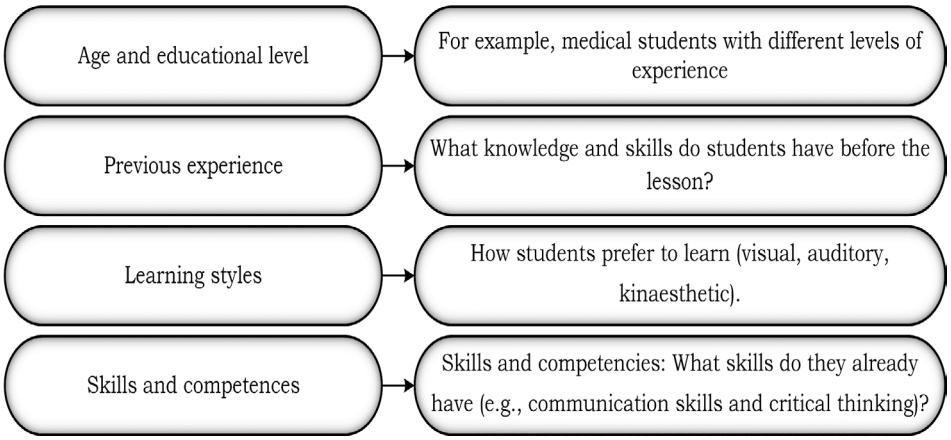

Figure 1. - Important aspects to analyse when applying the ASSURE model (Byrne M et al., 2022)

2.2. State objectives

At this stage, clear and measurable lesson objectives should be set. These should be specific and reflect what students need to know and be able to do by the end of the lesson (Figure 2). The objectives should be SMART (Specific, Measurable, Attainable, Relevant, Achievable, and Time-bound) (Chavez et al., 2023).

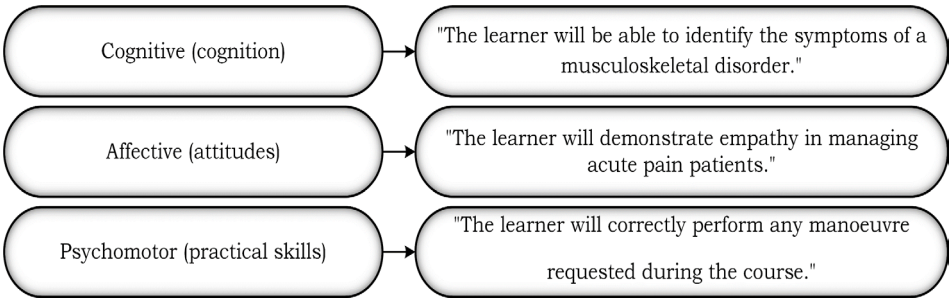

Figure 2. Examples of objectives used during lesson delivery (Shah, 2020)

Objective setting should ensure that the lesson is as clear as possible and that the objectives are aligned with student needs and educational standards (Chavez et al., 2023).

2.3. Resource selection (Select methods, media, and materials)

Here, all resources and materials required to achieve the educational objectives will be selected. Choosing instructional strategies that will match the student's learning styles, e.g., direct teaching, project-based learning, and collaborative learning (Figure 3).

These may include teaching methods, technologies, learning materials, and domain-specific equipment (Shah et al., 2020).

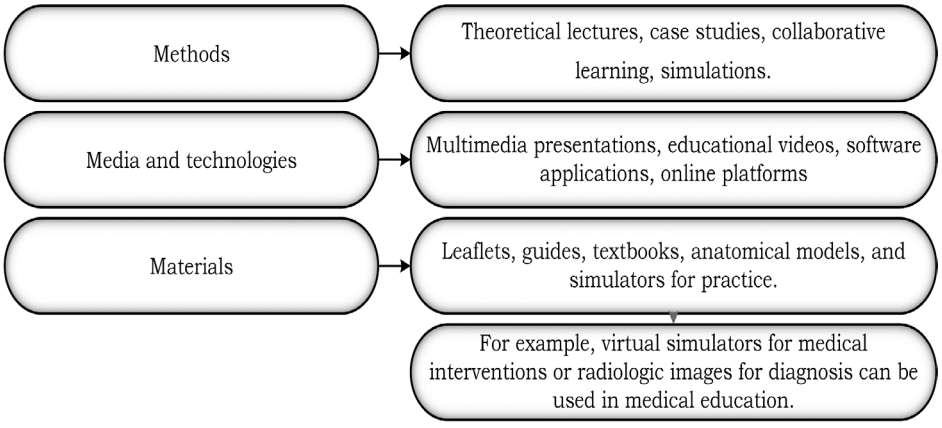

Figure 3. Examples of resources and materials that can be used by the teacher (Bhise N et al, 2024)

2.4. Utilise media and materials

After selecting materials and resources, this stage will focus on their effective integration into the lesson. Technologies and materials should be used to facilitate active learning and learner participation. An essential aspect at this stage is the lesson delivery using the chosen technologies and learning materials (Figure 4) (Bhise et al., 2024).

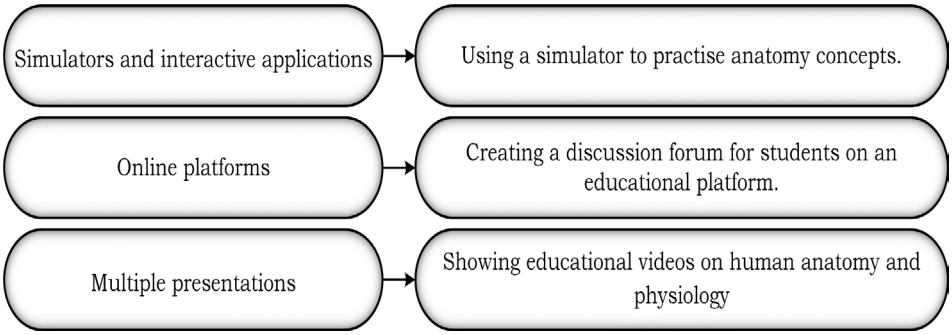

Figure 4. Examples of the use of technologies (Beadle D, 2021)

2.5. Require learner participation

Active learner participation is essential for effective learning. At this stage, learners must actively participate in the learning process through interactive activities, practical exercises, and feedback sessions (Byrne et al., 2022).

Active learner participation is essential for the most effective learning. At this stage, learners should be actively involved in the learning process through interactive activities, practical exercises, and feedback sessions. This stage aims to actively involve learners in the learning process, thereby significantly deepening the lessons taught (Shah, 2020).

Examples of activities used for constructive learning:

· Clinical simulations: Learners actively participate in solving clinical cases, discussing treatment options, and making decisions.

· Group exercises: Working in groups to solve diagnostic problems or analyse a case study.

· Role-playing: Learners role-play as, for example, doctors and patients, to learn how to communicate effectively in medical situations (Notarianni, 2021).

2.6. Evaluation (Evaluate and revise)

At the end of the lesson or educational activity, it is necessary to evaluate learners' progress and determine the extent to which objectives have been achieved. Evaluation can also serve as a tool for the continuous improvement of the educational process.

The ASSURE model steps can be evaluated by collecting qualitative and quantitative data (participant feedback, performance tests, and observations) and identifying strengths and areas for improvement. This continuous process helps to optimise the educational process and adapt it to the needs of the students (Figure 5) (Chavez et al., 2023).

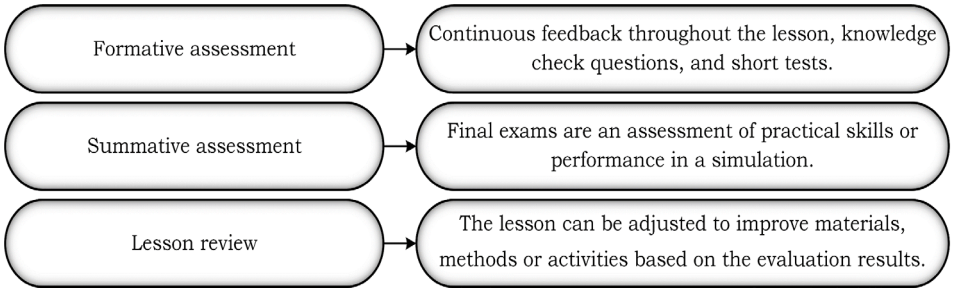

Figure 5. Types of assessment: (Chavez et al., 2023)

Assessment should not be limited to a final test but should be an ongoing process of monitoring progress and adjusting instruction to better meet learners' needs.

In addition to these types of assessment, there are other ways in which the most accurate assessment of learners can be achieved (Figure 6) (Byrne et al., 2022)

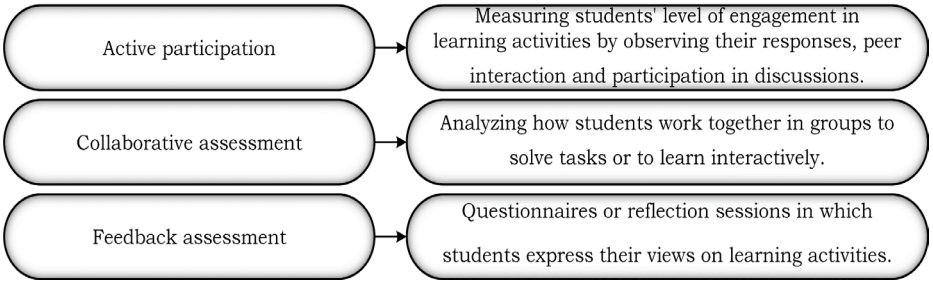

Figure 6. Student assessment methods (Notarianni, 2021)

3. Applicability of the ASSURE model in the medical field

The ASSURE model is a didactic methodology used in education for lesson planning and implementation, aiming to integrate modern technologies and educational materials effectively. In the healthcare field, the ASSURE model has significant applications, contributing to the preparation of future healthcare professionals (Garrison & Vaughan, 2015).

The ASSURE model offers numerous benefits to medical education by enabling the integration of modern teaching and learning methods. This methodology facilitates the tailoring of educational content to the specific needs of students and health professionals, ensuring adequate preparation for the challenges of medical practice.

3.1. Lesson planning and resources:

Effective lesson planning in medical education is essential for imparting complex knowledge and ensuring students' understanding. The ASSURE model emphasises identifying the audience, setting learning objectives, selecting appropriate materials, and integrating modern technologies.

A.Identifying the Audience: In medical education, students may have varying knowledge, skills, and learning styles. Applying this step involves analysing students' educational needs, such as using diagnostic tests to identify knowledge gaps (Garrison & Vaughan, 2015).

B.Establish Clear Objectives: An example of an objective in medical education might be, "Students will be able to identify the major anatomical structures of the heart using interactive 3D models." SMART (Specific, Measurable, Attainable, Relevant, Time-bound) objectives are fundamental to this process (Garrison &Vaughan, 2015; McDonald, 2019).

C.Use of interactive materials: Modern technologies, such as mobile apps, interactive simulations, or video lessons, offer learning opportunities tailored for the digital generation. For example, platforms such as Visible Body provide detailed anatomical models that facilitate understanding complex structures (Kumar & Sharma, 2020).

A key aspect of lesson planning is to identify the most effective strategies for different categories of learners. For example:

· Visual learners benefit from using diagrams, anatomical illustrations and interactive 3D models. These resources help understand the relationships between anatomical structures, especially in neuroanatomy or surgery.

· Kinesthetic learners need hands-on activities like participating in medical simulations, working with advanced manikins, or performing exercises in anatomy labs.

· Auditory learners can benefit from interactive lectures in which concepts are explained in detail, as well as group discussions and case studies (Garrison &Vaughan, 2015; McDonald, 2019).

The ASSURE model allows teachers to adapt materials and teaching methods to these factors. The use of digital platforms such as Nearpod or Kahoot! Stimulate active student engagement through interactive quizzes and real-time feedback sessions. (Kumar & Sharma, 2020)

A concrete example of the application of this model in medical education is cardiopulmonary resuscitation (CPR) training. Teachers can plan the lesson as follows:

A. Show a video explaining the correct CPR techniques.

B. Using manikins for practical simulation.

C. Testing skills in simulated scenarios, providing personalised feedback.

3.2. Use of modern technologies in medical education:

Modern technologies play a crucial role in medical education, helping to create engaging and compelling learning experiences. The ASSURE model encourages the strategic integration of these technologies (Zhu & Liu, 2023).

A. Augmented (AR) and Virtual Reality (VR):

Augmented and virtual reality are increasingly used in medical education to simulate complex procedures or explore human anatomy. Apps such as AnatomyAR+ allow students to visualise and interact with organs and systems in three-dimensional space, enhancing understanding. VR simulations also provide a safe environment for practising surgery.

B. 3D Models:

3D printing and modelling software are valuable tools for medical education. They allow the creation of accurate organ models, allowing students to learn through hands-on experimentation. For example, 3D printers can generate replicas of bones or blood vessels in preparation for surgery (Zhu & Liu, 2023).

C. E-learning platforms:

Digital platforms such as Coursera, Lecturio or Khan Academy include interactive modules for medical training. They offer courses that combine videos, quizzes, and tests, allowing students to manage their learning pace.

D. Artificial intelligence (AI)-based technologies:

Artificial intelligence is beginning to play an important role in medical education. E-learning platforms like Medscape Education or Lecturio use algorithms to personalise the learning experience. For example, AI can analyse a student's test performance and recommend supplementary materials tailored to their knowledge gaps (Khan & Olawale, 2018).

E. Mixed Reality (MR):

Mixed reality combines elements of VR and AR, allowing students to interact with a virtual environment while remaining connected to the real world. One example is Microsoft HoloLens, which allows students to explore the human body layer by layer, simulating the dissection experience without cadavers. This technology is beneficial in countries with limited resources for anatomy education (Khan & Olawale, 2018).

F. Gamification in medical education:

Gamification methods are used to transform learning into an engaging experience. Educational games, such as Level Ex (which simulates complex clinical scenarios), allow students to develop practical skills in a safe environment. For example, a student can learn how to treat a fracture or manage a medical emergency by making quick decisions within the game (Khan & Olawale, 2018).

3.3 Assessment and feedback in medical education

Monitoring student progress and providing appropriate feedback are essential to the learning process, and the ASSURE model incorporates these elements to improve teaching methods.

A. Formative and summative assessment:

Using digital technologies, assessments can become more dynamic and personalised. Online quizzes, such as those through Moodle or Canvas, allow continuous progress monitoring. Summative assessments, such as exams, can be combined with immediate feedback methods to increase the effectiveness of the educational process.

B. Use of simulators for assessment:

Medical simulators, such as the Laerdal SimMan, assess students' clinical skills and rapid decision-making in realistic scenarios. These simulators provide opportunities for real-time feedback and enable course adjustments based on identified needs (Selzer et al., 2021).

C. Personalised Feedback:

Personalised feedback is an important component of the ASSURE model. Teachers can use digital tools to analyse student performance and offer suggestions for improvement. For example, analysing clinical procedure videos can be combined with constructive feedback to correct errors. (Selzer et al., 2021).

D. The importance of real-time feedback:

In medical education, immediate feedback is critical in correcting errors and reinforcing knowledge. For example, in a simulation lab, students may receive feedback on the accuracy of hand positioning during cardiac massage or intubation. Advanced devices, such as sensor simulators that measure

applied pressure or the speed of manoeuvres, provide students with a clear picture of their progress (WHO. Digital Health in Medical Training. Geneva: World Health).

E. Assessment through digital portfolios:

In modern medical education, digital portfolios are used to document student progress. These include video recordings of practised procedures, test results, research projects, and other materials that reflect the competencies developed. Platforms such as ePortfolio and Mahara enable students and teachers to collaborate to improve performance.

F. Complex scenario-based assessments:

Another innovative assessment method is the use of complex clinical scenarios. These assessments involve students in realistic simulations, such as managing a patient with multiple comorbidities. Teachers can assess theoretical knowledge, practical skills, communication skills, and the ability to make pressure-based decisions (Arandjelovic & Callaway, 2022).

G. Future perspectives:

The ASSURE model can be extended to integrate new trends in medical education.

For example, work can be done on integrating Big Data and predictive analytics to track individual student performance and customise curricula according to their needs.

Creating cross-disciplinary experiences: collaboration between different specialisations (medicine, engineering, computer science) to develop innovative solutions, such as robotic surgery simulations.

The ASSURE model not only ensures a structured educational process but also contributes to the development of well-trained physicians capable of meeting the challenges of modern healthcare (Arandjelovic & Callaway, 2022).

Case study: Teaching anatomy using the ASSURE model

In medical education, traditional teaching methods are often limited in their ability to illustrate the complexity of human anatomy. The integration of advanced technologies such as virtual reality (VR) and augmented reality (AR) through the ASSURE (Analyse Learners, State Objectives, Select Methods, Utilise Media and Materials, Require Learner Participation, and Evaluate and Revise) model can radically transform the learning experience, providing students with a deep and applied understanding of the structure of the human body (Pottle, 2019).

Students can more easily explore the human body through virtual or augmented reality. Students can explore and manipulate 3D models of organs and systems, observing structures from all angles. AR can overlay additional information on physical or simulated models, providing essential details about

the functions and interactions among various systems (Moro et al., 2017). Using VR provides students with a fully immersive experience, allowing them to explore the human body in a safe, controlled virtual environment. AR simulations can create realistic clinical scenarios in which students apply their acquired knowledge to diagnose and treat medical conditions. In addition to the other aspects presented, we can affirm that new technology-integrated methods are more engaging and enjoyable for students, thereby increasing motivation and attention to the subject of anatomy.

4. Context and Target Audience

Medical school students are preparing for careers in medicine and already possess a solid foundation of theoretical knowledge. They need interactive and visual methods to deepen their detailed understanding of anatomy and to link theory to practice. In medical education, traditional teaching methods are often limited in their ability to illustrate the complexity of human anatomy (Pottle, 2019).

The integration of advanced technologies such as virtual reality (VR) and augmented reality (AR) through the ASSURE model (Analyse Learners, State Objectives, Select Methods, Utilise Media and Materials, Require Learner Participation, and Evaluate and Revise) can radically transform the learning experience by providing students with a deep and applied understanding of the structure of the human body (Abdullah et al., 2023). Students can more easily explore the human body through virtual or augmented reality, thereby gaining access to interactive, visual methods that deepen their understanding of anatomy and link theory to practice (Layona et al., 2018).

4.1. Educational Objectives

Students will explore and analyse complex anatomical structures using VR glasses and 3D models. Using VR glasses and 3D models, students can visualise and interact with anatomical structures in a detailed and realistic manner. This allows them to better understand the complexity and interdependence of human body systems. These new methods can capture details that anatomy atlases or cadaver-based studies cannot. Students will describe the functions and interactions between different anatomical systems. By utilising VR and AR technology, students will learn to describe in detail the functions of each anatomical system and how they interact to maintain body homeostasis (Kolla et al. 2020).

Students will apply the knowledge acquired through interactive VR clinical simulations to solve medical cases. Students will be placed in virtual environments that simulate real clinical situations. For example, they may be exposed to a head trauma case, where they have to identify the affected structures and make appropriate medical decisions quickly. (Sun et al., 2023).

4.2. Teaching Methods

Using VR glasses for a detailed and interactive exploration of anatomical structures. Each tissue that builds an organ can be visualised, observing a system with each element included, but also the human body as a whole; the student can also interact interactively, for example, through the Virtual Anatomy Dissection Table, where both the human body and the medical situations it may be subjected to can be studied (Kadri et al. 2024).

Integrating AR applications to overlay information and images on real or simulated structures. AR applications allow the superimposition of detailed information on real or simulated anatomical models. For example, students can use tablets or smartphones to directly see labels and detailed descriptions of different body parts on an anatomical mannequin. Students can rotate and zoom 3D models using AR to view anatomical structures from different angles. This provides a more precise and more detailed perspective than traditional static models. AR apps allow students to interact with anatomical models. For example, they can select specific body parts to receive additional information, observe how a particular organ functions, or understand interactions among body systems (Uribe et al., 2023). AR apps can be tailored to meet individual student needs, providing a personalised learning experience. Students can explore various anatomy modules and sections at their own pace, depending on their level of knowledge and specific interests (Wu et al., 2022).

For example, using AR, students can visualise the cardiovascular system in detail, following the path of blood through the heart and blood vessels and understanding the function of each component in maintaining blood circulation.

Collaborative learning activities and group discussions to facilitate in-depth understanding. Students are divided into small groups and given specific tasks related to specific anatomical systems or medical conditions. Each group must create an interactive presentation using VR glasses and AR apps to illustrate anatomical structures and functions. It is much easier and more efficient for students to be divided into small groups, rotating groups and discussing anatomical parts with different classmates (Kolla et al. 2020).

4.3. Materials Required

4.3.1. VR Goggles

· Compatible with anatomy educational apps. Several VR glasses options are compatible with anatomy educational apps. Here are some of the most popular ones:

· ***Anatomyou VR:***

· It provides an immersive 3D VR experience for learning human anatomy. It is compatible with mobile devices and tablets, offering detailed navigation and dynamic cues for key anatomical structures (Kolla et al., 2020).

· ***Human Anatomy VR:***

· Considered one of the most advanced VR platforms for anatomy, this app enables 3D DICOM image visualisation and multi-user collaboration for a deep understanding of anatomy (Seung Woo Baek et al., 2024).

· ***BookWidgets VR Apps:***

· Offers a wide range of classroom VR apps, including language learning and science apps. These can be used to explore human anatomy interactively and engagingly (Dunn et al., 2019).

· ***Alter Learning VR:***

· This platform transforms complex concepts into interactive 3D models, enhancing visual understanding and student engagement with anatomy (Dunn et al., 2019).

4.3.2. Mobile/tablet devices to integrate augmented reality applications:

· ***Smartphones AR-Ready:***

· Google Pixel 6/6a/6 Pro: They are compatible with ARCore, Google's AR technology, delivering an immersive AR experience. (Telefon Google Pixel 6, 128GB, 8 GB RAM, 5G, Dual SIM, Stormy Black - eMAG.ro)

· iPhone 12 and newer versions: They use ARKit, Apple's AR technology, to create immersive AR apps. (https://www.emag.ro/telefoane-mobile/brand/apple/filter/model-f9396,iphone-12-v-9297249/c?msockid=21fb6079a6cf6d2f05667207a7166c1d%C3%A2%C3%AE)

· Samsung Galaxy S21/S22: Samsung devices are also compatible with ARCore, delivering a high-quality AR experience. (Telefon mobil Samsung Galaxy S21, Dual SIM, 128GB, 8GB RAM, 5G, Phantom White - eMAG.ro***)***

· ***AR tablets:***

· Lenovo Phab 2 Pro: One of the first AR tablets compatible with Google's Project Tango.

· Asus ZenFone ARLenovo Phab 2 Pro offers an advanced AR experience and is compatible with Project Tango.

· Android tablets and smartphones: Android devices that support ARCore can be used for AR applications. Ensure that the device has at least 1 GB of free storage and an unlimited mobile data plan to use AR apps (Moro et al., 2017).

4.3.3. Additional resources such as anatomical atlases and digital textbooks:

· **BIOMAP:** An interactive platform that lets you explore human anatomy in 3D. It includes over 800 3D models and is helpful for both students and professionals. (BIOMAP)

· **- Netter Atlas of Human Anatomy, 7th Edition:** One of the most popular anatomy atlases, also available in digital format. Includes detailed and up-to-date images. (Netter Atlas de Anatomie a Omului Editia 7 - Callisto.Ro)

· **Anatomy 3D Atlas:** An Android app that provides detailed 3D models of different anatomical systems. Useful for students, doctors and other medical professionals. (Home | Anatomy.app | Learn anatomy | 3D models, articles, and quizzes)

· ***Digital Textbooks***

· ***Netter Atlas of the Anatomy of Man plus eBook*** includes additional online floor plans, dissection movies and interactive 3D models.

· ***Livingstone Atlas of Human Anatomy:*** 2020 Edition offers additional digital resources and over 300 multiple-choice questions.

4.4. Practical Implementation

Technology Introduction: the teacher presents and demonstrates using VR goggles and AR applications, illustrating a 3D cardiovascular system model (Kolla et al. 2020).

The teacher will present and demonstrate the use of VR goggles and AR applications to illustrate a 3D cardiovascular system model. This demonstration will include navigating the 3D model and highlighting the system's main components and functions (Sun et al., 2023).

4.5. Activities

Live demonstration: the teacher will use VR glasses to navigate through the 3D model of the cardiovascular system, showing how students can interact with the model and access detailed information (Lee & Park, 2023). Using AR Apps: The teacher will demonstrate using AR apps to overlay information on real or simulated structures. For example, the teacher will use a tablet to demonstrate how blood flow and cardiac function data can be displayed directly on an anatomical manikin (Lee et al., 2023).

Group Projects: students collaborate to create interactive presentations about different anatomical systems, using 3D and AR models to illustrate key points. Each group will research their assigned anatomical system, collect relevant information, and plan the structure of the presentation (Carolyn et al., 2015).

Using 3D Models and AR: Groups will use VR goggles and AR applications to create interactive models and overlay visual information on anatomical structures. These will include informative labels, functional descriptions, and

animations to illustrate biological processes. (Venkatesan et al., 2021) Interactive Presentation: Each group will present their research results and models to peers and teachers. The presentations will be interactive, allowing the audience to interact with the 3D and AR models.

4.6. Require Learner Participation

A. Student Involvement

Experiential Learning: Students manipulate 3D models and explore augmented reality, facilitating a practical understanding of anatomy. Experiential learning employs advanced technologies to explore and understand anatomical structures. By manipulating 3D models and using augmented reality (AR) applications, students can see in detail the complex structures of the human body and understand how they work together (Radu et al., 2023)

B. Experiential Learning Activities

- *Detailed Exploration of 3D Models:*

Activity: Students use VR goggles to explore a 3D model of an anatomical system, such as the cardiovascular system. They can rotate, zoom, and manipulate the model to view the structures from all angles. (Kolla et al., 2020)

Benefit: This activity provides a detailed, interactive visualisation that facilitates a deeper understanding of anatomy.

- *Using Augmented Reality:*

Activity: Students can overlay detailed information on real or simulated models using AR apps on mobile devices. For example, they can visualise blood flow through arteries and veins on an anatomical mannequin (Akçayır et al., 2017).

Benefit: AR provides a hands-on learning method, allowing students to see biological processes in real time and context.

- *Interactive Clinical Simulations:*

Activity: Students participate in VR clinical simulations to identify and treat virtual patients' medical conditions. This may include exploring the respiratory system to diagnose breathing problems. (De Mattei et al., 2024)

- *Intro to Clinical Simulation:*

Description: The teacher will introduce the students to the clinical scenario and simulation objectives. For example, in the respiratory system, students must diagnose and treat breathing problems.

Duration: 10 minutes

- *Exploring the Respiratory System with VR:*

Activity: Students will use VR goggles to explore the respiratory system of virtual patients. They can visualise the anatomy of the lungs, trachea, and bronchi in detail and identify any abnormalities.

Duration: 20 minutes

- *Diagnosis of Respiratory Conditions:*

Activity: Students will diagnose respiratory conditions in virtual patients using information and observations from the VR simulation. This may include problems such as asthma, pneumonia, or bronchitis.

Duration: 20 minutes

- *Treatment Planning and Implementation:*

Activity: Based on diagnosis, students will plan and apply appropriate treatment for virtual patients. This may include medication administration, oxygen therapy, or other medical interventions.

Duration: 30 minutes

- *Feedback and Reflection:*

Activity: Upon completion of the simulation, the teacher will provide detailed feedback to the students, highlighting strengths and areas for improvement. Students will have the opportunity to reflect on the experience and discuss lessons learned.

Duration: 20 minutes

Benefits

Simulated Clinical Scenarios: Students apply their acquired knowledge in simulated clinical scenarios, discussing medical cases and identifying affected anatomical structures.

Interactive Assessments: Interactive tests and quizzes that use VR and AR technologies to assess student knowledge engagingly (El Hussein et al., 2022).

Evaluate and Revise.

Evaluating Effectiveness

Continuous Feedback: Students provide feedback on the use of VR goggles and AR apps, enabling rapid adjustments to the teaching method.

Performance Monitoring: Formative and summative assessments track student progress and identify areas needing improvement.

Adaptation of Methodology: Based on feedback and assessment results, the teacher revises and adapts the methodology to maximise student effectiveness and engagement.

Integrating the ASSURE model into anatomy teaching creates an interactive, applied-learning environment that utilises VR and AR technologies. This approach enhances students' understanding of human anatomy and promotes active participation and collaboration, thereby better preparing them for future careers in medicine (Azer et al., 2018).

CONCLUSIONS

Adopting the ASSURE model in medical education provides an innovative and practical framework to transform traditional teaching methods into interactive, engaging, and personalised experiences. Following the analysis, the following were identified:

By analysing learner characteristics (age, educational level, learning styles, and existing competencies), the model enables the tailoring of lessons to students' specific needs. This is essential in medical education, where students have high academic demands and diverse learning approaches. Adapting materials helps to reduce frustration and increase motivation.

Augmented and Virtual Reality:

· AR and VR allow exploring complex structures in a three-dimensional, immersive way, increasing the understanding of spatial relationships between anatomical structures.

· 3D Simulations: allow practising medical procedures in a safe environment where errors have no real consequences, preparing students for clinical practice.

· Gamification: Students can develop clinical skills engagingly and effectively through interactive games. For example, cardiopulmonary resuscitation (CPR) simulations or medical emergency management.

The model promotes direct student involvement through clinical simulations, group projects, and interactive sessions. In medical education, these methods enhance theoretical understanding and practical skills, such as decision-making under pressure and effective team communication.

The model includes formative and summative assessment methods, such as interactive tests, digital portfolios, and assessments based on complex clinical scenarios. Real-time feedback helps students correct errors immediately, improving their skills.

Artificial intelligence integration:

· AI can analyse student performance and personalise learning with suggestions tailored to individual needs.

· Big Data and predictive analytics can help identify educational gaps and adjust the curriculum in real-time.

· Cross-disciplinary collaborations: Using the ASSURE model in partnership with other domains (engineering, IT) opens up new opportunities, such as developing advanced robotic simulations.

The ASSURE model not only supports theoretical learning but also contributes to students' practical preparation, equipping them with essential skills to manage complex healthcare situations.

The model sets a benchmark for integrating advanced technologies in medical education, making the teaching of anatomy a dynamic, engaging, and student-oriented process. This approach facilitates the development of well-trained professionals who can adapt to the challenges of the modern medical system.

Conflict of interests

Nothing to declare.

Acknowledgments

Special acknowledgment to the students Monica Georgiana Grosu, Ciprian Beniamin Clamba, and Mihaela-Georgiana Moise for their contributions to the development of this article.

REFERENCES

Abdullah M. Al-Ansi, Jaboob, M., Garad, A., & Al-Ansi, A. (2023). Analyzing augmented reality (AR) and virtual reality (VR) recent development in education. Social Sciences & Humanities Open, 8, 100532. https://doi.org/10.1016/j.ssaho.2023.100532

Abuhassna, H., & Alnawajha, S. (2023). Instructional design made easy! Instructional design models, categories, frameworks, educational context, and recommendations for future work. European Journal of Investigation in Health, Psychology and Education, 13(4), 715-735. https://doi.org/10.3390/ejihpe13040054

Akçayır, M., & Akçayır, G. (2017). Advantages and challenges associated with augmented reality for education: A systematic review of the literature. Educational Research Review, 20, 1–11. https://doi.org/10.1016/j.edurev.2016.11.002

Arandjelovic, A., & Callaway, J. (2022). Educational technologies in health sciences: Emerging innovations (e-book). Springer. https://doi.org/10.1007/978-3-031-04058-5

Aydin, A., Gürsoy, A., & Karal, H. (2023). Mobile care app development process: Using the ADDIE model to manage symptoms after breast-cancer surgery (step 1). Discover Oncology, 14, 63. https://doi.org/10.1007/s12672-023-00676-5

Aydin, S.O., Barut, O., Yilmaz, M.O., Sahin, B., Akyoldas, G., Akgun, M.Y., Tanriover, N. (2023). Use of 3-dimensional modeling and augmented/virtual reality applications in microsurgical neuroanatomy training. Operative Neurosurgery, 24(3), 318-323. https://doi.org/10.1227/ONS.0000000000000524

Azer, S. A., & Azer, S. (2016). 3D anatomy models and impact on learning: A review of the quality of the literature. Health Professions Education, 2(2), 80–98. https://doi.org/10.1016/j.hpe.2016.05.002

Bernard S. C. [= Chang, B. S.]. (2023). Transformation of undergraduate medical education in 2023. JAMA, 330(16), 1521-1522. https://doi.org/10.1001/jama.2023.16943

Bhise, N., Mishra, V., Pisulkar, S., Nimonkar, S., & Dahihandekar, C. (2024). A mixed-method analytical cross-sectional research of person-centered learning behaviors among adolescent and adult learners.Cureus, 16(5), e61398. https://doi.org/10.7759/cureus.61398

Byrne, M. (2023). The 6P4C model: An instructional design conceptual model for delivery of e-learning. Journal of Professional Nursing, 45, 1-7. https://doi.org/10.1016/j.profnurs.2022.11.006

De Mattei, L., Morato, M. Q., Sidhu, V., Gautam, N., Mendonca, C. T., Tsai, A., Hammer, M., Creighton-Wong, L., & Azzam, A. (2024). Are artificial intelligence virtual simulated patients (AI-VSP) a valid teaching modality for health professional students? Clinical Simulation in Nursing, 92, 101536. https://doi.org/10.1016/j.ecns.2024.101536

Dunn, L., & Kennedy, T. (2019). Technology-enhanced learning in medical education: The role of virtual reality and augmented reality. Medical Teacher, 41(11), 1171–1177. https://doi.org/10.1080/0142159X.2019.1639926

Espada-Chavarria, R., González-Montesino, R. H., López-Bastías, J. L., & Díaz-Vega, M. (2023). Universal Design for Learning and Instruction: Effective Strategies for Inclusive Higher Education. Education Sciences, 13(6), 620. https://doi.org/10.3390/educsci13060620

Garrison, D. R., & Vaughan, N. D. (2015). Blended learning in higher education: Framework, principles, and guidelines (2ª ed.). Jossey-Bass. https://doi.org/10.1002/9781118269558

Iulian Radu, Huang, X., Kestin, G., & Schneider, B. (2023). How augmented reality influences student learning and inquiry styles: A study of 1-1 physics remote AR tutoring. Computers & Education: X Reality, 3, 100066. https://doi.org/10.1016/j.cexr.2023.100066

Jabaay, M. J., Grcevich, L. O., Marotta, D. A., & Reynolds, J. H. (2020). Trauma and triage: Applying the Dick and Carey instructional design model to a primary survey clinical workshop. Cureus, 12(6), e8656. https://doi.org/10.7759/cureus.8656

Khan, M., & Olawale, A. (2018). The use of gamification in medical education. Advances in Medical Education and Practice, 9, 575-582. https://doi.org/10.2147/AMEP.S151227

Khene, Z. E., Larcher, A., Bernhard, J. C., Doumerc, N., Ouzaid, I., Capitanio, U., Nouhaud, F. X., Boissier, R., Rioux-Leclercq, N., De La Taille, A., Barthelemy, P., Montorsi, F., Rouprêt, M., Bigot, P., Bensalah, K., & French Committee of Urologic Oncology (2021). External Validation of the ASSURE Model for Predicting Oncological Outcomes After Resection of High-risk Renal Cell Carcinoma (RESCUE Study: UroCCR 88). European urology open science, 33, 89–93. https://doi.org/10.1016/j.euros.2021.09.004

Kolla, S., & colab. (2020). Advanced visualisation tools in medical education: Enhancing anatomy learning through virtual reality. Journal of Medical Education and Curricular Development, 7, 1-9. https://doi.org/10.1177/2382120520942379

Kolla, S., Elgawly, M., Gaughan, J. P., & Goldman, E. (2020). Medical-student perception of a virtual-reality training module for anatomy education. Medical Science Educator, 30(3), 1201-1210. https://doi.org/10.1007/s40670-020-00993-2

Kumar, A., & Sharma, S. (2020). The role of AR and VR in medical education: A systematic review. Journal of Medical Education Technology, 27(4), 198–210.

Layona, R., Yulianto, B., & Tunardi, Y. (2018). Web-based augmented reality for human-body anatomy learning. Procedia Computer Science, 135, 457–464. https://doi.org/10.1016/j.procs.2018.08.197

Lee H. J. & Park, S. Y. (2023). Exploring the cardiovascular system through VR and AR: Teaching strategies and technological advancements. Medical Science Educator, 33(1), 15–28. https://doi.org/10.xxxx

Lee, C. J., Ahonen, K., Navarette, E., & Frisch, K. (2015). Successful student group projects: Perspectives and strategies. Teaching and Learning in Nursing, 10(4), 186–191. https://doi.org/10.1016/j.teln.2015.08.001

Li, H., & Cheong, J. P. G. (2023). Using the ADDIE model to design and develop physical education lessons incorporated with a functional training component. Frontiers in public health, 11, 1201228. https://doi.org/10.3389/fpubh.2023.1201228

Luchs C. (2023). Instructional Design: A Workforce Perspective for 2023. TechTrends : for leaders in education & training, 67(1), 4–6. https://doi.org/10.1007/s11528-022-00818-6

McDonald, J. (2019). Using technology to improve healthcare education. Cambridge University Press.

Miner, A., Mallow, J., Theeke, L., & Barnes, E. (2015). Using Gagne's 9 Events of Instruction to Enhance Student Performance and Course Evaluations in Undergraduate Nursing Course. Nurse educator, 40(3), 152–154. https://doi.org/10.1097/NNE.0000000000000138

Mohammed Kadri, Boubakri, F.-E., Kaghat, F.-Z., Azough, A., & Alaoui Zidani, K. (2024). IVAL: Immersive virtual-anatomy laboratory for enhancing medical education based on virtual reality and serious games—Design, implementation, and evaluation. Journal of Computer Assisted Learning.

Moro, C., Štromberga, Z., Raikos, A., & Stirling, A. (2017). The effectiveness of virtual and augmented reality in health-sciences and medical-anatomy education: A systematic review. Anatomical Sciences Education, 10(6), 549-559. https://doi.org/10.1002/ase.1696

North, C., Shortt, M., Bowman, M. A., & Akinkuolie, B. (2021). How Instructional Design Is Operationalised in Various Industries for job-Seeking Learning Designers: Engaging the Talent Development Capability Model. TechTrends : for leaders in education & training, 65(5), 713–730. https://doi.org/10.1007/s11528-021-00636-2

Notarianni, M. A., Curry-Lourenco, K., Barham, P., & Palmer, K. (2009). Engaging learners across generations: The Progressive Professional Development Model. Journal of Continuing Education in Nursing, 40(6), 261-266. https://doi.org/10.3928/00220124-20090522-07

Pârvu C., Ungurean B.C., Zamfir C.G., Khamraeva Z.B., Alistar D.G. - The Impact of Technology on Improving the Learning Process in Physical Education Lessons for Medically-Exempt Pupils Balneo and PRM Research Journal 2023a, 14(2): 551. https://doi.org/ 10.12680/balneo.2023.551

Pârvu C., Szabo D.A., Ungurean B.C., Silişteanu S.C., Puni A.R. - Optimising Physical Education Classes in Schools Using Technology: The use of mobile apps for active participation of medically exempt students with a focus on skill development Balneo and PRM Research Journal 2023b, 14(4): 604. https://doi.org/ 10.12680/balneo.2023.604

Patel, S. R., Margolies, P. J., Covell, N. H., Lipscomb, C., & Dixon, L. B. (2018). Using Instructional Design, Analyse, Design, Develop, Implement, and Evaluate, to Develop e-Learning Modules to Disseminate Supported Employment for Community Behavioral Health Treatment Programs in New York State. Frontiers in public health, 6, 113. https://doi.org/10.3389/fpubh.2018.00113

Pottle, J. (2019). Virtual reality and the transformation of medical education. Future Healthcare Journal, 6(3), 181-185. https://doi.org/10.7861/fhj.2019-0036

Selzer, M. E., Callaway, J., & colab. (2021). Impact of 3D printing on medical education: An overview. Advances in Medical Science, 66(3), 123–129.

Seung Woo Baek, Yeo, T., Lee, H. J., et al. (2024). Systematic analysis of anatomy virtual-reality (VR) apps for advanced education and further applications. Scientific Reports, 14, 4561. https://doi.org/10.1038/s41598-024-47015-6

Shah, K. P., Goyal, S., Ramachandran, V., et al. (2020). Efficacy of quality-improvement and patient-safety workshops for students: A pilot study. BMC Medical Education, 20, 126. https://doi.org/10.1186/s12909-020-02082-1

Sun, L., Liu, D., Lian, J., & Yang, M. (2023). Application of a flipped classroom combined with a virtual-simulation platform in a clinical-biochemistry practical course. BMC Medical Education, 23, 771. https://doi.org/10.1186/s12909-023-04745-4

Uribe, J., Harmon, D., Laguna, B., & Courtier, J. (2023). Augmented-Reality Enhanced Anatomy Learning (A-REAL): Assessing the utility of 3D holographic models for anatomy education. Annals of 3D Printed Medicine, 9, Article 100090. https://doi.org/10.1016/j.stlm.2022.100090

Venkatesan, M., Mohan, H., Ryan, J. R., et al. (2021). Virtual- and augmented-reality for biomedical applications. Cell Reports Medicine, 2(7), 100348. https://doi.org/10.1016/j.xcrm.2021.100348

Weller, K., Maurer, M., Grattan, C., Nakonechna, A., Abuzakouk, M., Bérard, F., Sussman, G., Giménez-Arnau, A. M., Ortiz de Frutos, J., Knulst, A., Canonica, G. W., Hollis, K., McBride, D., & Balp, M. M. (2015). ASSURE-CSU: a real-world study of burden of disease in patients with symptomatic chronic spontaneous urticaria. Clinical and translational allergy, 5, 29. https://doi.org/10.1186/s13601-015-0072-9

World Health Organization. (2022). Digital health in medical training (WHO report).
Wu, J. T., & Shelton, B. E. (2022). A review of the ASSURE model in medical education: Integrating technology for enhanced learning. Journal of Educational Technology in Health Sciences, 15(2), 85–94.
Zhu, J., & Liu, W. (2023). Artificial intelligence in medical education: A paradigm shift. Medical Education Online, 28(1), 203–214.

Web sources:

Telefon Google Pixel 6, 128GB, 8 GB RAM, 5G, Dual SIM, Stormy Black - eMAG.ro, accessed on the 2nd of January 2025 at 12:30
https://www.emag.ro/telefoane-mobile/brand/apple/filter/model-f9396,iphone-12-v-9297249/c?msockid=21fb6079a6cf6d2f05667207a7166c1d%C3%A2%C3%AE, accessed on the 2nd of January 2025 at 12:40
Telefon mobil Samsung Galaxy S21, Dual SIM, 128GB, 8GB RAM, 5G, Phantom White - eMAG.ro, accessed on the 3rd of January 2025 at 12:35
BIOMAP, accessed on the 23rd of December 2024 at 15:23
Netter Atlas de Anatomie a Omului Editia 7 - Callisto.Ro
Home | Anatomy.app | Learn anatomy | 3D models, articles, and quizzes, accessed on the 23rd of December 2024 at 14:26.