

Incorporating Reflective Learning Practices In Medical Imaging Curriculum

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Purpose To provide an overview of the reflective learning cycle, as well as common reflective learning models, as a means of informing future implementation of reflective learning assignments in medical imaging curriculum.

Methods Journal articles were searched for in Google Scholar, ScienceDirect, and ResearchGate, as well as the university's library databases using the keywords *reflective learning*, *Kolb's model of learning*, *reflective learning practices in health care*, and *reflective learning in radiography*. Out of 19 articles found, 12 articles were selected based on inclusion and exclusion criteria.

Results The literature search yielded results in health care education, nursing, medicine, medical imaging and radiography, pharmacy, physical therapy, and occupational therapy.

Discussion Studies have shown that reflection is an integral aspect of learning and has substantial implications for learners' clinical practice. Reflection is a cognitive process that facilitates learning, assists in the understanding and application of knowledge to clinical situations, and develops new clinical knowledge in student radiographers. When reflective activities, such as journaling, portfolios, and problem-based learning, are scaffolded throughout the curriculum, students develop critical reflection skills that positively affect their clinical practice.

Conclusion Reflective learning practices can positively affect student learning, clinical decision-making skills, and patient outcomes. When reflective learning activities are incorporated throughout the curriculum, students are more effectively able to bridge the gap between theoretical knowledge and clinical practice. In addition, the reflective learning process allows learners to examine their clinical experiences while providing context for application and future clinical practice and continued learning.

Keywords | *reflective learning, Kolb's reflective model, radiography, health care education*

Critical-thinking and clinical decision-making skills are some of the more difficult attributes to develop in medical imaging students.¹ Students often struggle to integrate theoretical knowledge with clinical realities.² Reflective learning practices are teaching methods that can be applied to address the need for students who are critical thinkers capable of higher-level clinical decision-making and patient care.¹ Reflective learning practices can provide insight and advanced clinical decision-making skills by fostering self-awareness and increasing critical-thinking skills.¹⁻⁹ Reflective learning practices allow individuals to translate knowledge and experiences into practice using insights gained from reflection and evaluation.^{7,9}

Reflective learning practices can improve communication skills and allow the learner to gain knowledge through experiences.¹ Reflection allows students to examine new knowledge and skills to develop a new meaning through the integration of this knowledge, leading to a higher level of understanding.^{1,5,6,8}

Although the concept of reflective learning is applied in many medical imaging programs, it must be scaffolded (building of complex knowledge and skills through consistent introduction of simpler concepts) and structured appropriately to encourage student reflection and growth.^{1,2} Without the proper context and guidance, students often feel as though reflective writing and learning are afterthoughts, thus the

knowledge and skills gained are minimized.^{1,2} Often, medical imaging educators incorporate reflective assignments but do not understand the underlying concepts needed to make them as beneficial as possible. By understanding the common reflective learning models and theories, educators can structure reflective learning assignments that address each aspect of the reflection learning cycle, which results in higher application and clinical development for students. The purpose of this review is to provide an overview of the reflective learning cycle, as well as common reflective learning models, as a means of informing future implementation in medical imaging curriculum.

Methods and Results

A review of the relevant literature on reflective learning practices was performed. The impetus for this review was from the Reflective Learning Toolkit piloted by the Irish Institute of Radiography and Radiation Therapy.⁴ The Reflective Learning Toolkit introduced the concept of reflective learning and how it could be leveraged in the clinical education setting. It provided a foundational basis related to reflective learning models and practices. In addition, it provided examples of activities that could be incorporated and revised for educating health care students. Journal articles were searched for in Google Scholar, ScienceDirect, and ResearchGate, as well as the university's library databases. Articles were found using the keywords *reflective learning*, *Kolb's model of learning*, *reflective learning practices in health care*, and *reflective learning in radiography*. These keywords yielded results in health care education, nursing, medicine, medical imaging and radiography, pharmacy, physical therapy, and occupational therapy. Out of 19 articles, 12 articles were selected to provide a foundation for understanding the development and application of reflective learning practices in health care education. Exclusion criteria were articles published before 2018 and being too closely affiliated with primary and secondary education in children. Inclusion criteria for articles included in this review were:

- discussion of historical development of reflective learning
- Kolb's reflective learning model

- related to health care education, especially in radiography and medical imaging

Discussion

The reflective learning process allows the learner to deconstruct experiences while externalizing decision-making. It is a systematic process for thinking about experiences and providing context for application and future behaviors.⁵ It permits the learner to analyze patterns of behavior while challenging assumptions and perceptions related to clinical experiences. When radiologic science students engage in reflective learning activities, their level of application, critical thinking, and retention increased substantially.^{2,9,10} Reflective learning is a mental process of working through or making sense of an experience or situation and of reviewing the experience or practice to inform learning. Reflection challenges a learner's understanding, knowledge, skills, attitudes, and behaviors to encourage growth.^{5,9,11} Reflective learning offers a process for applying knowledge and skills into clinical practice.^{7,9} Students can apply their didactic knowledge and skills using a growth framework that encourages reflection on clinical strengths and areas for improvement.² Reflective learning has the potential to influence clinical behaviors and outcomes through the scaffolding of learning and application that occurs. Reflective learning practices allow for the development of new knowledge and clinical skills that improve professional practice.^{2,3,7,9}

Studies have shown that reflection is an integral aspect of learning and has substantial implications for learners' clinical practice.^{1-3,5,7,9} McCarthy et al studied student feelings on reflection as a clinical learning tool in undergraduate education.⁸ Their findings addressed student perspectives related to cognitive, affective, and behavioral aspects in relation to reflective learning practices.⁸ Data gleaned from the study indicated that reflection was a cognitive process that facilitates learning, assists in the understanding and application of knowledge to clinical situations, and develops new clinical knowledge.⁸ This knowledge construction occurs when the learner begins to reconcile the theoretical knowledge presented in the classroom with the clinical realities practitioners face.^{9,10} The student can visualize

how theoretical skills can be applied in the clinical setting.¹ The practice of reflection allows learners to integrate theoretical knowledge with clinical realities to inform their future clinical practices.^{2,9,10} Students stated that using reflection helped them to critically evaluate their actions during a clinical experience concerning what went well and how they could improve their performance for future clinical practice.^{2,8} They viewed reflection as a means of reviewing the experience critically and constructively for the purpose of redirecting how they would approach the experience in the future.⁸ Affectively, students viewed reflection as a method for breaking down what occurred and taking time to process the emotions associated with the experience.⁸ Reflection was viewed as increasing self-awareness while exploring the effect of their actions on others in the experience.⁸ Behaviorally, students saw reflection as a method for examining their actions during the experience and evaluating how they could change their actions in future practice.^{2,8}

Reflective practices are viewed as not only beneficial but transformational as the learner engages in a systematic process of deep learning.^{1,3,5,7,12} Reflection becomes transformational in that it improves clinical judgment while contextualizing various aspects of clinical practice.⁷ Studies also have shown that educators and students believe that reflective learning practices have enhanced students' communication skills, interprofessional collaboration, clinical knowledge, and competency in the clinical setting.⁷ Students have a situated view of how their clinical knowledge is applied to real-life patients and can use reflection to deconstruct each aspect of the experience. Benefits of reflective learning include increased self-directed learning, increased motivation, and enhanced patient care outcomes and quality.³ Increased awareness of feelings and emotions, increased self-confidence, increased mindfulness, and identifying areas to work on for future practice also are noted as benefits of reflective learning practices.^{1,8} Reflection has positive outcomes for students personally and professionally.^{1,8} It has been shown to increase students' levels of professionalism and respect for the diversity of patients, as well as reframe their attitudes and beliefs. Clinical expertise and decision-making are positively affected when learners

incorporate reflective learning practices.^{1,3,5} Reflective learning practices have been shown to assist learners in bridging the theory-practice gap while developing critical-thinking skills.⁵

The skills necessary for critical reflection can be taught or enhanced through the teaching of reflective strategies and well-developed experiential learning opportunities.^{1,3} There are 5 characteristics associated with reflective learning in health care: cognitive processes, strong critical elements, reviewing and deconstructing experiences to improve clinical practice, self-awareness and development, and emotional involvement.⁶ When reflective learning practices are scaffolded in a radiologic science curriculum, faculty can facilitate the connection between what the student has experienced during clinical rotations with the knowledge and skills taught in the classroom. Common outcomes associated with reflection include advanced knowledge and clinical skills, empowerment and autonomy, and increased use of reflection to improve clinical practices.^{1,6,7} Learners who practice critical reflection also develop a stronger awareness of their strengths and weaknesses, increased self-confidence and efficacy, reduced bias, and increased empathy.^{1,8}

Using key concepts to guide learners through reflection after a clinical experience is aligned with involving cognitive processes.^{6,7} These key concepts that guide reflective learning often are found in role-playing, case studies, problem-based learning, and simulations.⁶ When learners critically reflect by reviewing and deconstructing their experiences, they can make deeper connections between theory and practice while analyzing the implications of actions taken during the experience.⁶ These connections allow students to analyze a clinical situation and determine alternate courses of action and methods to achieve diagnostic images.¹

Reflective learning comprises 3 types of knowledge or skills: propositional, professional, and personal.^{5,13} Propositional knowledge includes didactic instruction and scholarly knowledge.^{5,13} Professional knowledge is considered discipline-specific and is derived from professional or clinical experiences.^{5,13} Personal knowledge is the learner's unique perspective or frame of reference.^{5,13} Personal knowledge is derived from critical reflection and allows the learner to situate

clinical experiences in propositional and professional knowledge realms.^{5,13} Educators use experiential learning, such as clinical experiences, to layer professional knowledge on propositional knowledge.^{5,8,13} By infusing reflective learning practices throughout an education program's curriculum, students progress from novice practitioners to expert practitioners.^{5,13} This progression is mirrored as students move through the program's clinical experiences. Students can incorporate clinical situations from one clinical rotation to the next, progressing from fledgling radiography students to competent, entry-level practitioners at graduation. Learners become expert practitioners through critical reflection throughout the various clinical experiences, allowing them to merge propositional and professional knowledge while situating it in personal knowledge bases.⁸

Reflective Learning Models

Reflective learning practices have evolved from several models and theories in education and learning.^{3,5} John Dewey, Jean Piaget, David Kolb, and Graham Gibbs have influenced the theories underlying the framework of reflective learning practices.^{3,7,9} Dewey is the founder of experiential learning, which incorporates aspects of reflection that situate new experiences acquired into older knowledge and skills.^{3,12,14} Experiential learning experiences permit learners to create meaningful connections between theoretical knowledge and applied knowledge by developing their own learning outcomes.^{9,12} Dewey's focus was on reflective practices' role in professional education, where they are used as a tool for reflecting on an experience to gain new understanding and knowledge that can be applied to future experiences.^{8,12,14}

Piaget believed that adults learn through adding new knowledge and experiences to older ones.^{3,12} Adults learn through the incorporation of new information and formation of new connections to older knowledge.³ In addition, these new connections are strengthened when paired with critical reflection.^{3,12}

Kolb produced numerous seminal works on experiential learning and professional practice.^{3,6,9} Kolb believed that reflective practices formed the bridge between thinking and doing, which can be seen as

applying theoretical knowledge to professional practice.^{3,9} Kolb's theories focus on the progression of information to knowledge through the 4 stages of learning.^{3,4,6,9,12} Kolb's reflective learning model provides a continuous loop of conceptualization, action with experimentation, and then reflection on the entire experience. Kolb's reflective learning model comprises a continuous loop of reflection and application.^{4,5} This continuous loop allows the learner to build on prior experiences and knowledge while applying them to new situations or experiences.^{3,15} Clinical faculty can use reflective learning practices to help students clinically mature and develop in the short and long term.⁹

Gibbs's reflective cycle encompasses 6 sequential steps related to reflective learning practice^{4,6}:

- description
- feeling
- evaluation
- analysis
- conclusion
- action

Gibbs's model builds on Kolb's and provides a more detailed description of the progression through the reflective process, especially concerning the analysis and evaluation of the experience, particularly the emotional aspect of the experience.^{5,6} The first step requires individuals to describe the experience they will reflect on. In contrast, the second step has them recall and explore the feelings and emotions associated with this experience.^{4,5} This second step of the model aligns with self-reflection and awareness. The third and fourth steps ask the individual to evaluate and analyze.^{4,5} During evaluation and analysis, the learner views the experience from the perspective of which aspects were challenging and which were positive.¹¹ Part of the analysis stage requires the learner to make sense of the experience and recognize how it affects their clinical practice and decision-making.⁵ During the conclusion stage, the learner explores relevant clinical literature and propositional knowledge to understand the experience better and determine other courses of action in the future.⁵ Learners then review the experience and make a judgment about what occurred during the incident while breaking down each component of the experience.⁴ By breaking down the individual components of

the experience, learners can determine what needs to be learned from this experience and develop insight and conclusions regarding their and others' behavior. The final step, the action plan, is where the learning is translated into practice, with the learner evaluating how to act when this experience occurs in the future.^{4,5} During this final stage of the reflective model, learners map out approaches that can be applied to similar experiences in the future.⁵

The integrated reflective framework introduced by DunnGalvin et al proposes the scaffolding of reflective practices throughout undergraduate curriculum.³ This integrated framework is derived from Kolb's and Gibbs's reflective learning models.^{3,5} This framework begins with stage 1, where the learner describes the action, event, or experience and involves simple reflection on the experience. Stage 2 requires the learner to confront the unknowns and make sense of the experience or event. Learners can ask questions about why this event occurred or how it made them feel. In stage 3, the learner analyzes and evaluates the experience by critically reflecting on how the event could have been handled differently or how another clinician would handle the experience.³ The final stage (4) is when learners experiment, modify, and apply their knowledge or skills to the clinical environment.³ Stage 4 is the application of the knowledge and skills learned through the reflective process. This is the stage where learners reflect on how their performance or clinical decision-making was affected and improved.³ As learners progress through the 4 stages of reflection, they move from simple reflection, describing the experience, to more critical reflection, where they ponder how their clinical practice was affected and how their new knowledge and skills will be applied to their practice in the future.³ If an integrated model of reflection is engrained in the curriculum, students begin to practice critical reflection more routinely after clinical experiences. This integrated model leads to a culture of critical reflection in the clinical environment, positively affecting patients.

After reflective learning experiences, educators should debrief learners using questions from the reflective learning model used during the experience.⁶ The debriefing by instructors further solidifies the experience and situates it in a professional context.

Pedagogical Approaches to Reflective Learning

Several pedagogical approaches can be used when incorporating reflective learning into a curriculum.^{4,7} Baird views reflective learning as a means to develop students into competent radiographers.^{2,9,10} The integrated reflective framework aligns well with radiologic science education, both didactically and clinically. Many health care programs have students develop portfolios or complete reflective journaling assignments related to clinical experiences.^{2,7,9} Reflective learning activities might include critical incident analysis or reflective group discussions.⁸ These types of assignments promote increased experiential learning through self-reflection.² One method for facilitating reflection could include reflective writing and journaling using the 4 stages for reflective learning. Faculty can develop reflective writing assignments that build on one another as students progress through the program. For example, faculty can choose a guided reading related to emotional intelligence or leadership for a clinical course; then a reflective writing assignment is given in which students must relate the concepts presented in the guided reading to their clinical experience and growth. This type of assignment allows insight into the students' reflective skills while also encouraging them to reflect on a portion or the whole of their clinical experience. It allows students to move through each stage of the integrating reflective learning model. When faculty build each writing assignment on the previous one and connect them to clinical practice, students can critically reflect on their experiences and subsequently grow as a result of this reflection into a more reflective practitioner who performs with increased clinical decision-making and critical thinking.⁹ The **Table** presents an example of a reflective writing rubric. Topics that also could be addressed in learners' reflective writing assignments are communication, ethical considerations, infection control issues, and radiation protection and safety.

Other examples of a reflective writing activity include learning logs or self-reported questionnaires that require the learner to reflect on a specific case or problem-based learning to develop reflective learning skills. Problem-based learning also is used to indoctrinate students into clinical scenarios where they will acquire new knowledge and skills while practicing

Table 1

Reflective Writing Rubric^{9,14}

Criteria	Description
Professional development	How the clinical experience affected the learner's professional development.
Learner's thoughts regarding the clinical experience	Emotions and feelings that arose during and after the experience. What went well and what could be improved? Learner strengths and areas for improvement.
Connection to guided reading	What concepts or principles from the guided reading have you incorporated into your clinical practice? What was the outcome of this? How can you continue to grow using the concepts described in the guided reading?
Connection to theory	Connection to theoretical knowledge (ie, best practices).
Clinical significance	Significance of the clinical experience. How will you grow and move forward as a clinical practitioner using the concepts from the guided reading and from your past clinical experiences?
Conclusion	-

reflective learning and critical thinking.^{16,17} Problem-based learning scenarios use a constructivist reflective learning framework to assist students in building clinical knowledge and skills through scaffolded experiences.^{16,17} Many programs heavily use case studies or simulation exercises that require students to role-play in a scenario to foster reflective learning.^{3-5,7,15}

Adequate debriefing should be a key component of any reflective learning experience.⁷ Much of the reflective learning process fosters autonomy and self-awareness, but faculty act as facilitators and lightly steer learners through the process.^{7,16} When implementing reflective learning into courses or curriculum, faculty should model reflection throughout while providing guidance as learners progress through the reflective learning cycle.^{7,16} Providing a more comprehensive framework that addresses how to critically reflect also has proven vital to improving the reflective learning and writing of students in medical imaging programs.⁹ This framework could include development of a module that addresses what reflective writing is and why it is performed, reflective learning models, challenges and barriers to reflection, and interpreting clinical scenarios using a critical reflection model.⁹

In addition, faculty feedback after reflective learning activities has been shown to negate overly critical or negative reflection by the student.⁸ Cue questions and key concepts allow faculty to guide learners through reflection while ensuring they do not form incorrect conclusions.⁷ Guided discussions allow learners to reflect on the conclusions and actions others might have developed during the activity.⁸ Learners new to reflection often benefit from structured reflective guides or prompts as they move through the activity, providing a framework for novices.⁸

Conclusion

Reflective learning practices can positively affect student learning, clinical decision-making and skills, and patient outcomes. By scaffolding opportunities for reflection throughout the curriculum, students can bridge the gap between theoretical knowledge and clinical practice, an area students struggle in as they progress through the program. They often experience a disconnect between what they are taught didactically and what they encounter in the clinical setting. By using reflection throughout a health profession curriculum, students can progressively develop their reflection skills as they apply them to clinical situations

and practice. The reflective learning process allows learners to examine their clinical experiences while providing context for application and future clinical practice and behaviors.

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References

1. Aaron L, Hicks J, McKnight A, Andary J. Reflection as a tool for personal and professional development. *Radiol Technol*. 2021;93(2):130-140.
2. Morris M, O'Connor M. Clinical portfolios as a tool to develop competence in radiography education. *Radiography (Lond)*. 2023;29(3):617-624. doi:10.1016/j.radi.2023.04.003
3. DunnGalvin A, Cooper JB, Shorten G, Blum RH. Applied reflective practice in medicine and anaesthesiology. *Br J Anaesth*. 2019;122(5):536-541. doi:10.1016/j.bja.2019.02.006
4. Irish Institute of Radiography and Radiation Therapy. Reflective Learning Toolkit. Published June 10, 2020. Accessed April 7, 2023. <https://www.iirrt.ie/7135-2/>
5. Paterson C, Chapman J. Enhancing skills of critical reflection to evidence learning in professional practice. *Phys Ther Sport*. 2013;14(3):133-138. doi:10.1016/j.ptsp.2013.03.004
6. Husebø SE, O'Regan S, Nestel D. Reflective practice and its role in simulation. *Clin Simul Nurs*. 2015;11(8):368-375. doi:10.1016/j.ecns.2015.04.005
7. Mantzourani E, Desselle S, Le J, Lonie JM, Lucas C. The role of reflective practice in healthcare professions: next steps for pharmacy education and practice. *Res Social Adm Pharm*. 2019;15(12):1476-1479. doi:10.1016/j.sapharm.2019.03.011
8. McCarthy B, Bessell N, Murphy S, Hartigan I. "Nursing and speech and language students' perspectives of reflection as a clinical learning strategy in undergraduate healthcare education: A qualitative study". *Nurse Educ Pract*. 2021;57:103251. doi:10.1016/j.nepr.2021.103251
9. Hamilton J, Druva R. Fostering appropriate reflective learning in an undergraduate radiography course. *Radiography (Lond)*. 2010;16(4):339-345. doi:10.1016/j.radi.2010.03.005
10. Baird M. Towards the development of a reflective radiographer: challenges and constraints. *Bijj*. 2008;4(1):e9. doi:10.2349/bijj.4.1.e9
11. Gunn T, Jones L, Bridge P, Rowntree P, Nissen L. The use of virtual reality simulation to improve technical skill in the undergraduate medical imaging student. *Interact Learn Environ*. 2018;26(5):613-620. doi:10.1080/10494820.2017.1374981
12. Chan CKY. Exploring an experiential learning project through Kolb's Learning Theory using a qualitative research method. *Eur J Eng Educ*. 2012;37(4):405-415. doi:10.1080/03043797.2012.70659613
13. Higgs J, Titchen A. Rethinking the practice-knowledge interface in an uncertain world: a model for practice development. *Br J Occup Ther*. 2001;64(11):526-533. doi:10.1177/030802260106401102
14. McInerney J, Baird M. Developing critical practitioners: a review of teaching methods in the bachelor of radiography and medical imaging. *Radiography (Lond)*. 2016;22(1):e40-e53. doi:10.1016/j.radi.2015.07.001
15. Davitadze M, Ooi E, Ng CY, et al. SIMBA: using Kolb's learning theory in simulation-based learning to improve participants' confidence. *BMC Med Educ*. 2022;22(1):116. doi:10.1186/s12909-022-03176-2
16. Arruzza E, Chau M, Kilgour A. Problem-based learning in medical radiation science education: a scoping review. *Radiography (Lond)*. 2023;29(3):564-572. doi:10.1016/j.radi.2023.03.008
17. Lawal O, Ramlaul A, Murphy F. Problem based learning in radiography education: a narrative review. *Radiography (Lond)*. 2021;27(2):727-732. doi:10.1016/j.radi.2020.11.001