Online Learning Strategies and Practical Tips for Nuclear Medicine Instructors

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Abstract

      As nuclear medicine instructors shift towards online learning, it is imperative to employ instructional strategies that align with the program's theoretical foundation. Online learning does not require a complete course design, though attention should be paid to careful course design to support learning, promote student engagement, and facilitate competency development. Instructional strategies such as discussions, group projects, and gaming elements support the construction of knowledge and the development of self-efficacy and competency while keeping students engaged in the content. Intentional display and formatting such as content chunking and a variety of materials can also support student learning.

Online Learning Strategies and Practical Tips for Nuclear Medicine Instructors

As the recent pandemic forced an abrupt shift into online-only education, nuclear medicine educators rushed to learn technology, adjust instructional and assessment methods, and redesign courses mid-semester to support student learning. An abrupt transition to online learning can be difficult for instructors and students, particularly if either is inexperienced or uncomfortable with an online format. Nuclear medicine education can be effectively delivered in an online format, though thoughtful modifications to course design and delivery are necessary.

Transitioning to online courses does not require a complete course redesign, but it does require modifications to instructional strategies to best support online learning. Instructional strategies should align with the theoretical foundation of the program or course. (1) With the rising popularity of online learning environments, it is imperative for educators to employ instructional strategies for student motivation and engagement to maximize authentic learning. This article provides a brief overview of instructional strategies for teaching nuclear medicine technology students online, as well as offering practical tips for delivering quality online education.

Theoretical Foundations

The appropriate choice of educational theory is imperative to program effectiveness, especially regarding career education. Student success in career education programs extends far beyond the classroom. Career education requires the development of knowledge as well as successful, efficient, and repeated demonstration of new skills (2). In short, student success is marked by the ability to effectively, repeatedly, and efficiently perform all entry-level aspects of a job upon graduation. Successful education in career programs require a hybrid theoretical model that includes behaviorism, social cognitive theory, and constructivism. The Joint Review Committee on Educational Programs in Nuclear Medicine Technology (JRCNMT) emphasizes

the achievement of technical and professional competencies (3). The technologist section of the Society of Nuclear Medicine and Molecular Imaging (SNMMI-TS) provides a curriculum guide that recommends educational programs adopt competency-based education theory (CBE) (4). Therefore, nuclear medicine education has a heavy emphasis on competency-based education theory, which has roots in behaviorism, social cognitive theory, and constructivism.

Competency-based education (CBE) is an educational theory that evolved as a hybrid model with roots in behaviorism, constructivism, experiential learning, and social-cognition (5, 6). CBE is a hybrid theory that adopted key concepts of existing educational theories to create a method for constructing knowledge and modifying behavior until students achieve mastery in critical technical skills and learning objectives (7). Competency-based education borrows scientifically grounded concepts from existing educational theories to form a hybrid type of educational approach intended to help students construct knowledge and develop critical behavioral outcomes through experience in their chosen profession. Competency-based teaching has five major tenets: clear alignment with expected competencies, focus on fostering learning and self-governance, criteria-driven with focus on accountability and competency, connection to real-world experiences, individualized and learner-centered (7).

Behaviorism is evident in career education because the purpose of the program is to teach new skills (2). Behaviorism is rooted in conditioning through stimulus-response (8). Educating adults in career education requires the development of behavioral based outcomes of skills that are needed in that career which students should be able to perform upon graduation. Researchers note that behavioral learning techniques such as operant learning programs are essential to students learning new skills and complex procedures in career education programs (9). Aliakbari et al. maintain that operant conditioning can be seen in many career programs because behavior modification and reinforcement are essential for the development of new career skills (10).

Behaviorism is evident in the competency-based nature of career education as students must be able to perform entry-level requirements of the career upon program completion.

Social-cognitive theory is centered on the belief that learning occurs in the social domain and includes learning techniques such as observation and role-modeling (2). This is a key component of career education and is seen in activities such as job shadowing, internships, and clinical education. An additional key component of career education is the development of professionalism and professional practices for the career being studied (10). Adults learn by observing others or through role-modeling (2). Role-modeling is also seen in internships or clinical education in which students can learn from other more experienced professionals in the field. Constructivism is based on the premise that learning is the students' construction of meaning from their experiences (2). Constructivism theory maximizes the students' learning through well-planned and structured experiential learning, enabling them to construct fundamental knowledge and develop needed skills. Constructivism, like social cognitive theory, places importance on the social aspect of learning, which is a key factor in adult education (7). Other well-known theories within constructivism are Vygotsky's theory of the zone of proximal development and scaffolding, which describe the progression of constructing knowledge. These theories specifically describe the development of new, complex knowledge and skills. Scaffolding, in particular, includes working with others who have higher abilities than the student to serve as an apprenticeship (10).

Application of a hybrid model of behaviorism, social-learning theory, and constructivism will support adult learning in competency-based career education programs (7). Behaviorism supports the development of new skills through reinforcement and conditioning in response to stimuli, which helps learners develop new skills needed for their career. Social-cognitive theory

supports the development of professionalism, career skills, and allows the application of knowledge in the real-world setting through the use of observational learning and role modeling. Lastly, constructivism supports the construction of knowledge and the development of new skills by providing structured experiential learning and scaffolding of complex work tasks. When transitioning courses from a live in-person format to online learning, it is imperative to align instructional strategies with educational theory and the theoretical foundations (1).

Instructional Strategies

Instructional strategies are the techniques instructors use to help students learn or gain a deeper understanding of content (10,11). They are techniques for engaging and motivating students, as well as supporting learning. Instructional strategies are an essential aspect of course design because they allow the instructor to make purposeful decisions about content delivery and assessment that help keep the course aligned to objectives and outcomes while also helping students gain meaningful knowledge (10, 11). Instructional strategies for CBE should be learner-centered and focused on the development of competency, connection to real-world application, and allow for self-reflection to foster self-governance and accountability (7) (Table 1). CBE requires both teaching and learning to be purposeful. This section is not an all-inclusive list of instructional strategies for online learning or for CBE, though it provides several examples of effective strategies for CBE in the online format.

Lectures

Lectures can occur in many forms in the online format, though it is not recommended to hold two or three-hour live lectures online (12). Students may begin to feel disengaged and authentic learning is undermined with lengthy lectures. In online learning, lectures work best when utilizing short lectures to provide a foundation for a topic or lesson and should not exceed

twenty minutes at a time (7, 12). Lectures can be provided as a voice-over power-point, live presentation, pre-recorded, or a podcast. Effective online learning utilizes short lectures to supplement learning in combination with other methods that are student-centered and require participation. Programs like Storyline and Techsmith Relay allow instructors to create or embed short videos that can serve as an introduction or summary to a topic or a tutorial accompanied by other assignments and resources. If utilizing lectures, Americans with Disabilities Act (ADA) accommodations such as transcripts and closed captioning should be available for all students. Additionally, live lectures can be used as a short supplemental clarification of commonly made student mistakes or a question-and-answer session at the end of an online module.

Case studies

Case studies tie into several learning theories and support development of critical thinking and competency (12). Although this is often used to present images to students, case studies do not have to be images. Case studies present a student with a clinical problem but not a clear solution. Case studies may even be combined with small group work that provides opportunities for brainstorming and social learning (12). Some video-conferencing platforms allow for breakout sessions that support this type of instruction. Case studies are beneficial for supporting the development of practical knowledge and helping students think like a technologist. Examples include image analysis or review, a complex clinical case, or an interesting/unusual quality control finding or image.

Gamification

Gamification of courses is defined as the incorporation of game-like activities or concepts into learning. Gamification is a broad term that could be as complex as creating a virtual game or incorporating game elements into course content. Gaming is increasingly used as an instructional

strategy in online courses (13, 14). Gamification of online course elements supports

constructivism and behaviorism which contribute to the development of competency through the

construction of knowledge and behavior modification (14).

In an online learning environment, gaming has the potential to improve student

engagement, motivation, and self-efficacy and support the achievement of behavioral objectives

(13, 15, 16). Research has shown that deep learning in the online learning environment is highly

dependent on student engagement, making it necessary for online educators to consider student

engagement (13, 17). The use of gaming in online courses can assist students in learning new

behaviors or encourage the repetitive behavior that leads to habitual performance of an

occupational skill (12). Gaming is a method for providing reward or punishment for behavior

modification to help students meet behavioral objectives (13). The use of gaming in online

courses may be a method of applying operant conditioning to improve student engagement,

student motivation, student self-efficacy, and achievement of learning outcomes (14, 15, 16, 18).

Additionally, gaming allows students to learn consequences from their mistakes in a virtually

real environment in which the consequences are minimized (14). Instructional games can also

strengthen critical-thinking and support social learning.

Incorporating gaming into an online course can be a complex and intimidating task for

instructors. One method to incorporate gaming into an online course by hosting a trivia-based

game. Some power-point and presentation software programs have free templates for trivia and

jeopardy in which the instructor only needs to add the questions and answers while the template

tallies the score for each team. Some video conferencing programs such as Zoom allow for

break-out rooms which instructors can use to break classes into more manageable teams. Many

Learning Management Systems (LMS) have add-on apps that can be used to award students with

badges for successfully completing modules or tasks. Using this method, students can be

rewarded for collecting badges or scoring points. Some free programs exist that allow instructors to create choose-your-own-adventure style games which can be embedded into an LMS (13, 15). Choose-your-own-adventure games take a bit of time to design and learn the platform. Still, they are beneficial in helping students achieve behavioral outcomes by learning positive and negative consequences for the behaviors they choose (13, 15). Choose-your-own-adventure style games can be useful for teaching students topics such as troubleshooting of equipment, handling a radioactive spill, or other imperfect scenarios encountered as a technologist.

Discussions

Discussions are among the most widely used instructional strategies in online classrooms, and the most effective (12). Effective use of discussion posts appeal to adult learners and supports social learning and construction of knowledge. Discussion posts not only keep students engaged; they also create interactivity (12, 19). Discussion posts are beneficial in providing a sense of connectedness and belonging to students, as well as strengthening the connection to the content (19). Discussion prompts that are problem-based also foster critical thinking and the construction of practical knowledge (20).

A recent example prompted students to script how they would explain a nuclear stress test to a patient and take a patient history. Students commented that this prompt made them think critically about the overall process of a stress test and why specific preparation and history questions are performed. Students remarked that it helped them see the bigger picture and put the whole process together. Feedback from peers clarified areas of confusion, and receiving feedback from peers boosted their confidence. Using a prompt that ties into a real-world scenario also helps students connect theory to clinical and understand the importance of the assignment. Weaknesses of discussions can be addressed and offset with prior planning. A frequent

complaint of students with discussions is that it feels like busywork. A frequent complaint from instructors with discussions is that students do not seem to take them seriously, or they are disappointed by students' lack of effort in discussions or replies to peers (12). Both complaints can be addressed and mitigated with a little prior planning. Effective use of discussions includes setting clear guidelines and expectations for the students, providing a rubric, and aligning the assignment to outcomes and objectives (19). If students are new to discussions, providing a good and a bad example can help students know what is expected of them. A common method of discussion posts requires students to reply to one or two of their peers. To avoid short replies such as "great job Suzie," instructors can place a minimum word count to the reply and provide students with clear expectations or a template for replies. One method requires each reply to be at least 100 minimum words, with one open-ended question and supporting evidence to either agree or disagree with the classmates' original post. Students can find JNMT journal articles or other scientific journals and texts to either support a student's post, clarify misunderstandings, or reaffirm the information is correct. Students may need reminders to make all posts professional, supporting the development of professional competencies and communication. Caution should be taken in assigning too much weight to discussion posts, which is more likely to lead to redundant or meaningless posts and incidents of plagiarism (12). When discussions are utilized in a course, it is recommended they account for less than twenty percent of a course's total grade (1).

Group Projects

Group projects can be difficult to facilitate and motivate all students in the online format, though it can be done effectively (1). Some problematic aspects include difficulty in the group being able to meet or communicate effectively due to varied schedules and unequal participation

or division of work by individual members. Online group project assignments should be carefully designed to promote individual accountability while maintaining clear interdependence (1, 20). Practical tips for incorporating group work are regular self-evaluations and periodic feedback from the group. Group projects support the JRCNMT's professionalism competencies because group projects require interpersonal social skills based on behaviorism, social cognitive theory, and constructivism while improving students' small group social skills and communication.

As an example, a group project into radiation safety in which each small group is given a different scenario which requires students to 'think like a technologist' to design a nuclear medicine department, develop a radiation safety plan, and develop the application for accreditation. This project requires the students to apply knowledge from the course, principles of ALARA, and critically examine the regulations and accreditation standards. Projects like this are an instructional strategy that supports several learning theories including social learning, constructivism, problem-based learning, competency-based learning, and behaviorism. At the end of the project, each group presents their scenario plan to their classmates and submits the' written plan. Each student completes a reflection, self-evaluation, and peer evaluation. The instructor should check-in with each group on a regular basis to see how students are assigning personal responsibility and dividing the work. Students should feel both accountable and supported knowing there are clearly set expectations and responsibilities. Group projects in which the students present to the class support social-learning theory. Projects such as this also create a competency-based assessment and an artifact that serves as an alternative to testing (1).

Assessments

Assessment of student learning can be difficult in online learning. Many proctoring options exist to protect the integrity of online exams, though students determined to cheat

continue to find innovative ways to cheat on exams. Several assessment strategies apply to online learning, which align nicely with various educational philosophies and instructional methods (1). Although quizzes and exams remain an important aspect of nuclear medicine education, other assessment strategies effectively support competency-based education in the online setting (1, 7). Students in online classrooms should be given a variety of assessment methods aligned with a variety of learning assignments. Student digital presentations, student-generated videos, and student presentations are also examples of assessments.

Creation of a project or portfolio in which the student must synthesize information and construct an artifact supports competency-based education provides a non-testing method for assessing student learning (1). Open-ended projects such as a design plan or training manual help students connect course content to the real world in a way that is meaningful and translates to deep learning. Portfolios and project presentations challenge students to think critically to apply and synthesize content, challenge students to demonstrate higher-order thinking, and foster authentic learning (1,7).

Practical Tips for Quality eLearning

Careful attention and slight changes to course design, organization, and the visual representation of the online course can support quality learning in an online format. Technological competence, communication skills, feedback skills, and providing student support are all important factors in an instructor's ability to deliver quality education online (21). Additionally, ADA compliance and students' ability to navigate the online content and locate necessary assignments and materials are important indicators of quality online course delivery. There are some things an instructor can do in the online organization and presentation of the course to support quality delivery and student learning.

Course Design

The course design refers to the organization of the course in the LMS and the visual presentation. The course should follow a logical flow so students can navigate the course easily (22, 23). LMS navigation menus should be as condensed as possible with no unusable options displayed for students. A "Begin Here" module containing links to student resources, the course schedule, and information on how and when to contact the instructor help students visualize the organization and expectations of the course. Gradebook weighting and due dates available at the onset of the course help students assume responsibility for their own learning and organization (22).

Special attention should be given to course and lesson directions. Course assignment directions should include details of expectations and formatting, how to submit the assignment, alignment to objectives, and grading rubrics (23). Course alignment to assignments and assessments supports adult learning theories and helps students know why the content or assignment is important. On the contrary, a lack of clear instructions can leave students feeling confused, overly anxious, and may decrease self-efficacy. Each module should contain the objectives, materials, videos, graphics, assignments, and assessments for that lesson or content so students can easily access what is needed for that lesson (22, 23).

Content Chunking

Content chunking is a way of breaking the content into smaller pieces, making it easier for students to focus in-depth on the topic and prioritize information (24). Content chunking is designed to build on the learners working memory and ties into both constructivism and competency-based learning. To employ content chunking, the instructor can use the LMS to organize lessons into focused modules. Each small module or lesson should include prioritized information, include only relevant information with carefully chosen content and visuals, and

take advantage of bulleted and numbered lists to organize concise information. A lesson organized in this way will be divided into several pages of the LMS module so students can progress screen by screen through the lesson (24).

Variety

Varying instructional material supports learning for all learning styles. This can be accomplished by incorporating assigned readings, videos, short live or recorded lectures, graphics, and concise notes (23). Additionally, hands-on activities or experiential learning activities that can be incorporated into the lesson will help kinesthetic learners, as well as supporting the development of competency. Varying assessment methods to assignments, papers, tests/quizzes, digital presentations, and projects also support competency development. The application of a variety of instructional strategies and learning materials supports student engagement and helps the instructor reach students with all learning styles (23).

Incorporating Technology

The use of various types of technology in a course can add to the variety of instructional materials and support student engagement with the topic. There are nearly endless options for incorporating instructional technology platforms into an online classroom. Platforms like Knowmia, Adobe Connect, and Articulate Storyline allow online instructors to create short effective videos and interactive learning resources that engage students and provide valuable learning. Although some nuclear medicine training videos do exist on YouTube, these platforms also provide a tool for instructors to create high-quality videos and lectures that can be uploaded to YouTube or the LMS. Virtual classrooms can also be created through Microsoft teams or Google Classroom that enable instructors to have video conferencing, live lecture capabilities, and facilitate group work.

Instructor Feedback

Instructor feedback is vitally important to student success in an online environment (19,21, 23). Effective online instruction includes frequent, consistent, and constructive feedback. CBE, as well as constructivism and behaviorism, require the educator to act as a facilitator and a mentor providing constant feedback so the student can modify behavior. Frequent and productive feedback contributes to students' self-efficacy and motivation (1). Constructive feedback included strengths and weaknesses as well as suggestions for improvement. Frequent and constructive feedback fosters student learning (1,6,23). It is recommended to set aside time each week to communicate with students and provide personalized feedback.

ADA Compliance

Designing an online course should take the Americans with Disabilities Act (ADA) into consideration (23). Consistency in the course design is essential for equal access and ADA compliance. Headers, texts, and fonts should be consistent throughout the course so screen readers can read them (22). Accessibility documents can be created in Word though documents should be also be provided in pdf form. All media should have good sound quality and a transcript or closed captioning provided. Images should contain alternative text (22). Individual institutions may have guidelines available for ensuring the course is ADA compliant.

In conclusion, effective online instruction requires careful course design and implementation, as well as effective communication. Online courses should be modified from traditional face-to-face learning to incorporate effective online learning strategies. All course materials, assignments, and assessments should maintain alignment to learning theory as well as course and program objectives. A variety of instructional strategies, materials, and assessment methods help reach students of all learning styless, support student motivation, and

foster student engagement. Instructional strategies for online nuclear medicine education include short lectures, discussions, case studies, course gamification, and group projects. Assessments and feedback should be given frequently so students can modify working knowledge and behavior as they progress toward competency. Thoughtful design and effective course management support student success and the development of competency in the online environment.

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Table 1: Instructional Strategies for Competency-Based Education Online

Learning Activities	Assessment Methods
Short lectures	Exams and quizzes
Case Studies	Presentations, Student Videos
Gaming Elements	Case-study Analysis
Discussions	Project Artifacts (Design plan, training manual, etc.)
Group Projects	Portfolios

CBE online should include a variety of student-centered instructional strategies to support the construction of knowledge, behavior modification, social learning, and competency development.