Developing Computer Simulations for Student Assessment

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ATHLETIC TRAINING professional preparation has undergone tremendous reform in the past decade, placing a greater emphasis on outcomes-based education. Outcomes-based education requires clinical proficiency assessment, which reflects the synthesis of foundational professional behaviors with cognitive and psychomotor competencies. Clinical proficiencies relate to a student's critical thinking, decision making, skill application, and overall ability to function in real patient care situations. However, due to the somewhat unpredictable nature of the clinical environment, educators often need to simulate clinical problems to assess clinical proficiencies.

Computerized simulations provide an opportunity for student practice and/or assessment of critical thinking and decision making related to specific clinical proficiencies. Simulations are widely used in a variety of educational contexts including medicine,[1] rehabilitation services,[2] nursing,[3,4] and business.[5] Doyle[1] describes four general categories of computer-based simulations used in medicine: screen-based text simulators, screen-based graphical simulators, mannequin-based simulators, and virtual reality trainers. The purpose of this report is to present a user-friendly, step-by-step road map for designing screen-based text simulations for athletic training education.

Benefits of Computerized Simulations

Traditional educational simulations are defined as sequential decision-making scenarios in which students take on "real life" roles to manage a discipline-specific task.[6] Computer-based simulations create a virtual decision-making environment that requires the student to think critically about a problem.[7] The use of simulation supports learning by requiring the student to assume the role of a certified athletic trainer (ATC) and allowing him or her to make modifications throughout the learning process without the potentially adverse consequences associated with a real situation.

Simulations can be used in two different contexts: student practice and student self-assessment. When simulations are used for practice, they provide a structured (scaffolded) environment in which students can function safely. By design, effective computer simulations require students to make complex clinical decisions, thus providing a mechanism for assessment of critical thinking and problem-solving abilities.[6] Research indicates that simulations assist students with the process of knowledge transfer from the classroom into real-life situations.[6] Thus, computer simulations for student assessment may provide an excellent mechanism to document progress in critical thinking and decision making in the learning over time continuum that precedes a student's application of clinical proficiencies with real patients.

Several benefits of using simulations have been identified in the literature. First, learning is most effective when it occurs in the appropriate context.[8] Computer simulations can provide a real-world context, which requires the student to assume the role of an ATC in evaluating complex patient problems. Research indicates that simulations enhance the transfer of learning by helping students visualize potential situations in which the knowledge would be useful to solve clinical problems.[9] Simulations can provide specific details about a patient scenario that mimic a real encounter in the athletic training room, thus allowing a student to make a clinical decision without fear of its consequence. Embedded in the simulation is the correct sequence of actions an expert clinician would follow. The goal is for the student to reach the point at which he or she takes the correct actions. There are also "distracter" paths that clinicians may have taken in the process of developing clinical expertise. These distracter paths must be credible, given the scenario, so as to encourage an increase in student ability to discriminate and make appropriate clinical decisions. For example, students could work through a clinical problem involving a patient with an eating disorder without fear of mismanaging the situation.

Computer simulations are not intended to provide an all-encompassing tool for clinical education, and some athletic training competencies and proficiencies do not lend themselves to computer simulation. For example, if your objective is to assess a student's ability to physically perform a basic psychomotor skill, such as a valgus stress test of the knee, you may not be able to effectively assess the skill with a computer simulation. However, if your objective is to assess the student's ability to critically think about a patient with a knee injury and make a series of clinical decisions that are based on the given patient information, a computerized simulation may be an appropriate pedagogical tool.

In addition to its value as a method for assessing clinical proficiencies, computer simulations provide realism, emotional arousal, excitement, and motivation for learning.[5] Utilization of computer simulations in a curriculum may prove to be particularly beneficial to students as the Board of Certification (BOC) exam transitions to a computer-based format. Although the precise configuration of the computerized BOC exam has not yet been revealed, we speculate that the use of computer simulations in athletic training education programs will familiarize students with computer-based testing.

Designing Effective Simulations—Backward Design

When designing effective computerized simulations, it is important to focus on simulating the intended task and to avoid a scenario that is too broad or vague.[7] We will use the example of developing a simulation for recognizing the signs and symptoms of skin conditions to illustrate the process we used to design a computerized simulation (Table 1). We began by selecting the clinical proficiency that relates to the clinical scenario to be simulated. Simply stated, what is the educational objective for the simulation? In this example, the goal was to assess a student's ability to recognize signs and symptoms, provide proper acute care, and make appropriate referral decisions for common skin conditions.

Table 1. Steps for Developing an Effective Educational Simulation
Step One: Identify the educational goal/objective for the simulation.
Step Two: Determine what the final outcome will be for the simulation.
Step Three: What strategies do I want the student to use in order to reach this diagnosis?
Step Four: What will be the differential diagnoses in this simulation?
Step Five: What information do I need to build into the simulation for students to use in the critical thinking and clinical decision-making process?
Step Six: Develop an opening scenario that provides basic information about the patient.
Step Seven: Develop decision-making points that are appropriate to the scenario. (i.e., history questions, observation, palpation, etc.).

Using a process called backward design,[10] our next step was to determine the final desired outcome for the simulation. Determining the desired outcome first allows you to create a much clearer path through the simulation. The intended outcome for our example was the ability to diagnose tinea corporis and to provide appropriate care and referral for the condition.

The strategies the student should use to reach the final step of the simulation need to be identified in order to include all of the appropriate information.[11] The student should possess an appropriate cognitive level to effectively navigate the scenario. In our example, students needed to synthesize information obtained in a patient interview and physical exam to develop a differential diagnosis. Therefore, it was essential for us to provide enough information about the scenario to allow the student to synthesize information and identify multiple possible diagnoses. Because this scenario involved a clinical diagnosis, we needed to predetermine the differential diagnoses. In this case, the differential diagnoses were molluscum contagiosum, tinea corporis, impetigo, and contact dermatitis.

The next step in developing the simulation was to identify the information that students would need to use in the clinical decision-making process. In our example, students need to ask a variety of history questions and assess patient responses. In order to provide a "real life" perspective on the situation, we included a picture of the skin condition (tinea corporis) in the computer simulation, which required the student to perform a thorough inspection of the affected skin area.

We found it helpful to shift our focus to the beginning of the scenario at this point in development of the simulation. This helps to pull the pieces of the scenario together. As demonstrated in Figure 1, the opening scenario should provide just enough information for the student to begin thinking about the possible outcomes and to begin consideration of the next action step. Our goal was to "connect the dots" and develop decision-making points that were appropriate for the scenario (i.e., history questions, observation, palpation, etc.). We found it useful to visually map the order of the simulation. Figure 1 illustrates the planning process we used for developing the simulation. In our example, students have the option to ask a variety of history questions and to observe the affected area. Palpating the skin lesion would not be a desirable choice, but it is

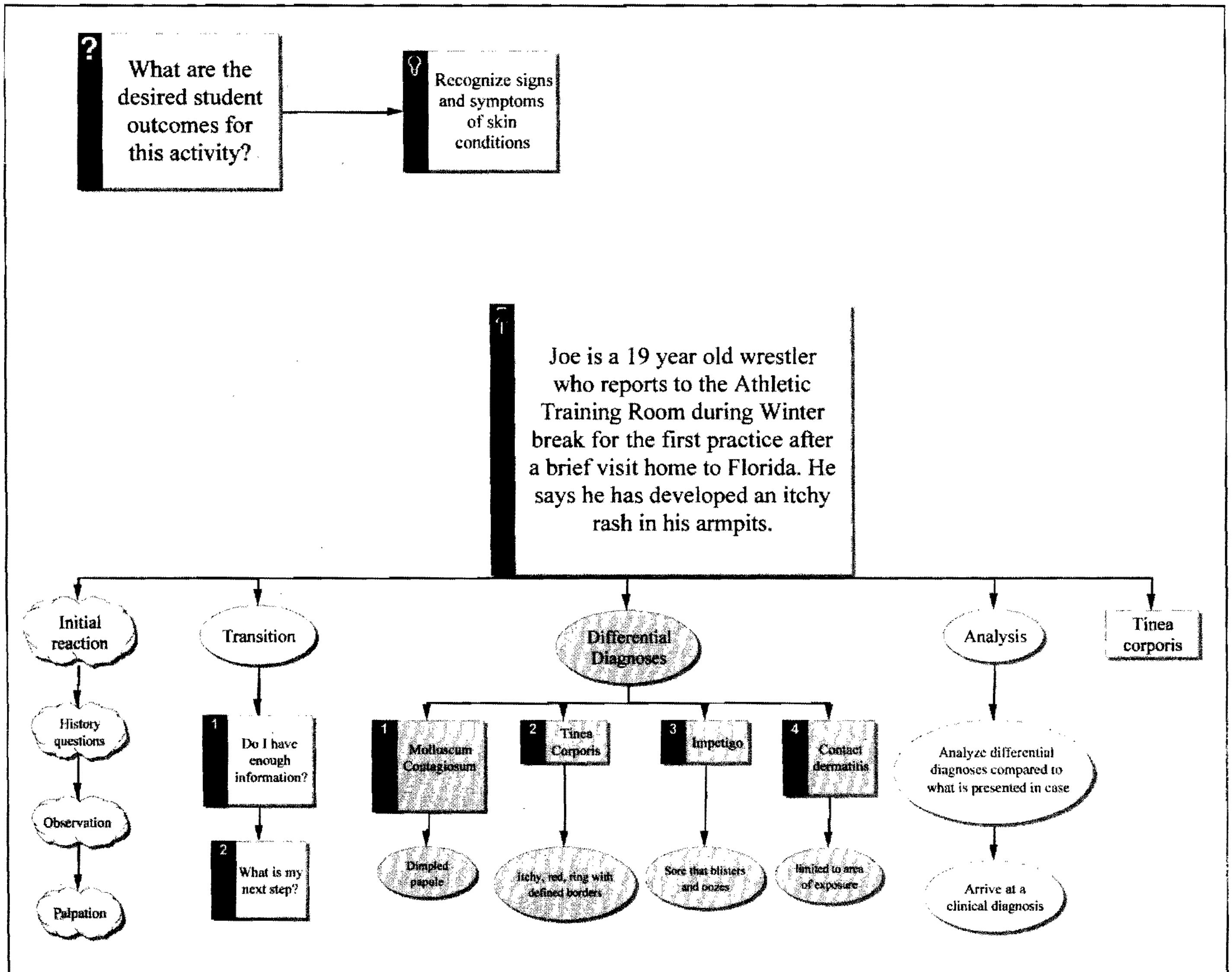

Figure 1 Educational simulation.

included to assess the appropriateness of the student's clinical evaluation process. It is important to include distracters in the scenario that may not be relevant to the condition or may be associated with a wrong clinical decision.

Implementing the Simulation

There are several software tools available for implementing computerized simulations, including Quandary Version 2.0 from Half-Baked Software, Inc. (www.halfbakedsoftware.com) and Higher Level Thinking, LLC (www.higherlevelthinking.com). We used Quandary to create our simulations, and we liked its intuitive nature and low cost ($50 per user license). Quandary is a web-based tool that uses a series of Action Mazes®, which present the user with a number of decision points that provide action options within the interactive simulation.[12] Upon choosing an option, the user is presented with feedback on the consequences of the choice and another set of options. The user can choose more than one option in each frame. Quandary advocates using Action Mazes® for problem solving, tutorials, diagnosis, and procedural training.[12] Several examples of Action Mazes® are available for viewing at website, www.halfbakedsoftware.com.

Conclusions

Assessing student learning with computer simulations provides educators with the flexibility to customize clinical scenarios that are specific to learning objectives. Regardless of which computer software program is used, the key to designing effective simulations is implementation of a step-wise process that begins with the identification of desirable outcomes and is followed by the creation of clinical scenario elements that will help students to ultimately achieve the desirable outcomes. ▮

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