The Use of Case-Based Learning in Veterinary Medicine

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IDT 612: Final Project Phase II

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August 19, 2019

Topic

In veterinary medical education, case-based learning is used extensively to teach critical thinking skills. Many veterinary medical educators use case presentations and Subjective Objective Assessment Plans (SOAP) reviews to build problem-solving skills. While the use of case-based learning is extensive in the human medical and veterinary medical education, there is little evidence-based research to prove that the use of case-based scenarios brings about active learning.

Introduction

The "learn by doing" approach is the foundation for goal-based scenarios (GBS). Schank, Berman, and Macpherson (1999) developed GBS. This "learn by doing" approach causes the learner to pursue a goal by practicing target skills and using relevant knowledge to achieve a goal. GBS design is found to provide motivating and sensible context and will aid their understanding of the relevance of the skill they are learning. GBS is also referred to as scenario-based learning and in medical education as case-based learning. In veterinary medical education, case-based presentations and SOAPS provide the scenarios that bring relevance to the educational process.

This paper will examine two fronts concerning case-based learning. First, it will compare and contrast case-based learning (CBL), problem-based learning (PBL), experiential learning theory, and inquiry learning theory. Second, while there were many articles are showing how case-based learning provides positive results in learning, many of the articles referenced note that there is not enough evidence-based research to prove the effectiveness of case-based learning on achieving learning outcomes in medical education. This paper concludes with an examination of the role CBL plays in veterinary education by addressing whether all medical concepts should be taught using this method, or should it be used as an adjunct to traditional instructor-centered methods as a way to increase motivation?

What is Case-Based Learning (CBL)?

Teaching and learning must encourage the learner's engagement. In veterinary medical education, there are core medical concepts that provide the foundation for the skills needed in practice after graduation. Learners need to understand how the knowledge of anatomy, physiology, pharmacology, and clinical pathology is integrated and used in the diagnosis and treatment of a patient case. According to Andrea, Laszlo, and Abdelfattah (2019), CBL helps students integrate basic medical science knowledge, apply that information, and use it to solve clinical cases. CBL is not meant to be a stand-alone teaching method as in the use of the lecture in the traditional classroom. Instead, an instructor provides case-based activities and incorporates them into a lecture-based course. Instructor provided case-based activities were used in McFee, Cupp, and Wood's (2018) study. In their research, learners had a more positive reaction when case-based activities were added when compared to traditional lecture-based courses. Case-based activities are a way to connect the knowledge and skills participants are learning in their core classes with real-life patient scenarios.

Task-Centered Learning Versus Problem-Based Learning

In the literature, a term commonly seen in discussions of case-based learning is problem-based learning (PBL). Before a discussion on CBL versus PBL begins, one needs to examine another approach known as problem-centered learning (PCL) or task-centered learning (TCL). To avoid confusion, the term task-centered learning will be used in place of problem-centered learning.

Education is a way to prepare learners for real-world scenarios by requiring them to apply knowledge, complete meaningful tasks, and solve problems. Instructional design and strategies in veterinary education advocate centering learning on real-world problems. Two models that use this approach is PBL and TCL. According to Francom and Gardner (2013), while PBL and TCL have similarities, there are also differences that will be elaborated.

TCL uses real-world tasks as the central strategy and is sometimes referred to as problem-centered learning. Francom and Gardner (2013) explain that real-world tasks advocate certain practices of design and teaching that focus on enhancing student learning and transfer. Instead of using only lectures, TCL has the learners apply their knowledge by completing real-world tasks.

In a publication only a few years after Francom and Gardner's 2013 study, Van Merrienboer and Kirschner (2018) examined the TCL approach and found that integrating the participant's knowledge skills and abilities with the skills they are learning during the training will allow the transfer of the new material to new problem situations. When one updates knowledge, skills, and abilities, they don't fade away once the learner has completed the training. Updating knowledge, skills, and abilities cause a transfer of learning and is known as complex learning (p. 2). In complex learning, as the learner moves through the training, each step in the task becomes increasingly difficult. Learners use their experience and knowledge learned from the previous steps to manage the new learning scenario.

Consequently, the training increases from just learning the steps to learning how to solve problems and think creatively to adjust to the challenges of the task. The holistic design approach attempts to integrate the potential challenges of the task as each step is taught. As Francom and Gardner (2013) found in their study, TCL potentially provides a "practical middle ground" between the cognitive view on the way information is processed to increase the efficiency of learning and the constructivist view that requires that learners must solve complex problems to construct their knowledge.

Problem-based learning (PBL) originates in medical education. According to Francom and Gardner (2013), Savery (2009), and the publication Learning Theories (2017), the goal is to develop problem-solving skills among learners while they learn. It is student-centered learning that presents with small groups that use problems as the impetus for learning. Working in groups, the learners are provided with a problem to solve, and the instructor plays the role of the facilitator. As each task is performed, they have to solve another problem. Learner's benefit from this approach since it improves problem-solving skills. Hence, PBL and TCL are similar in that they both use center learning using real-world examples and require the learner's knowledge to solve these problems or tasks.

Both PBL and TCL are influenced by situated learning as they situate learning activities through the use of problems and tasks similar to real-world environments. According to the Northern Illinois University Faculty Development and Instructional Design Center (n.d.), Stein (1998), and Clancey (1995), situated learning is an instructional approach that creates active student participation using activities from daily living. Clancey also elaborates that situated learning is concerned with how learning occurs every day because humans, by nature, conceive what is happening around us and gain knowledge from the experience. It is the study of how human knowledge develops in the course of an activity and how those activities are interpreted.

Francom and Gardner (2013) emphasize that TCL is more influenced by cognitive information processing, whereas PBL has a strong constructivist epistemological influence. The goal of TCL is to produce effective application, and transfer of knowledge to realistic contexts in an efficient manner as the activity connects to the learners existing knowledge.

Case-Based Learning versus Problem-Based Learning

The literature reviewed by this paper was consistent in noting CBL and PBL are distinct instructional strategies. McFee, Cupp, and Wood (2018) explain that while each approach requires the solving of a problem, the acquisition of new knowledge is different when you compare one with the other. PBL involves a more open-ended exploration into a topic where the learner must determine through developing and testing hypotheses, what they need and seek out additional resources. The hypotheses that are most appropriate will either prove or disprove the learner's argument. CBL, on the other hand, is used to supplement the traditional curriculum through the introduction of basic concepts before the discussion of the case that is to be used. A facilitator or instructor uses guiding questions to keep the learners on track with the planned learning objectives.

Additionally, Setia et al. (2011) provide an alternative comparison of PBL versus CBL. They explain that CBL uses a guided inquiry method which provides more structure to the session. PBL has an open inquiry approach where the is little to no guidance from a facilitator or instructor. This discussion of guided inquiry and guided inquiry were also discussed in Srinivasen, Wilkes, Stevenson, Nguyen, and Slavin (2007). Interestingly, this study also discussed that PBL improves problem-solving skills through independent learning and teamwork, but facilitators cannot correct inaccurate learner assumptions. Those that are not in agreement with the CBL approach find the guided method potentially stifles curiosity as learners realize their instructor will guide them to the right answer.

Experiential Learning Theory and Inquiry-Based Learning

The roots of case-based learning come from experiential and inquiry-based learning. This section of the paper will discuss each one of these learning theories and its connection to case-based learning. Both experiential learning theory and inquiry-based learning are used heavily in STEM programs as they both are used to teach the scientific method. In Bailey's (2019) article, the scientific method is a series of steps used to answer specific questions about the natural world. The steps involve making observations and building questions from those observations to form a hypothesis and conducting an experiment to prove or disprove the hypothesis. Experiential learning theory and inquiry-based learning focus on the interaction of the learner with the activity and how it builds knowledge from the experience of that interaction.

Experiential Learning Theory

John Dewey was an educationalist and theorist who introduced experiential learning theory to modern education based on the writings of the well known Greek philosophers such as Aristotle, Plato, and Socrates. Dewey's book entitled *Experience and Education* (1938) asserted that all learning is experiential. All instruction must also, therefore, be experiential with the learner being the participant that is created in the learning environment.

Experiential learning theory was further developed by David Kolb, who believed that when one experiences an activity, one learns and builds knowledge from that experience. According to the publication, Learning Theories (2017), experiential learning theory presents a cyclical model of learning that consists of four stages. The first stage is "DO" or concrete experience (CE), where the learner actively experiences the activity in a lab session or fieldwork. The second stage is "OBSERVE" or reflective observation (RO) when the learner reviews back on the experience. The third stage is "THINK" or abstract conceptualization (AC), where the learner attempts to pull together a picture of what was observed. Lastly, stage 4 is "PLAN or active experimentation (AE) where the learner tests picture or model for an upcoming experiment. Lindsey and Berger (2009) note that it is essential that the experience has to be arrested, examined, and analyzed to generate useful knowledge from it.

Regarding instruction using experiential learning theory, Lindsey and Berger (2009) explain that learners may experience activities differently, which could affect gaining the required knowledge. One solution is to carefully examine the experience and the individual's interpretation of that experience in collaboration with their classmates. Lindsey and Berger revisit the Schank, Berman, and McPhearson's (1999) paper and attest that three universal principles should be used chronologically when designing instruction: 1) framing the experience, 2) activating the experience, and 3) reflecting on the experience. Framing the experience is the design of measurable learning objectives. Activating experience requires that the learner have authentic experiences and challenges to engage and cause the knowledge to transfer. The learner should see the relevance of the activities to their learning needs. Reflecting on the experience allows the learner to analyze their experience and learn from it.

One example of the use of these three learning principles can be found in the use of the instructional strategy InterPLAY. Stapleton and Hirumi (2014) found that future generations of leaners needed to be better prepared for a rapidly changing world. These changes require that learners become more advanced in innovative thinking and creative problem-solving skills. InterPLAY is a learner-centered approach for improving innovative thinking and problem-solving skills using relevant, meaningful, and engaging challenges. They further explain that emotions and imagination have a direct impact on how and why learning occurs. The InterPLAY Model uses three basic conventions: story, play, and game using real-world conditions to incite an emotional investment with the topic. Story, which uses the elements of events, character, and worlds, stimulate the emotions using plot. Play, which uses the elements stimulus, response, and consequently, invite participation. Game, which uses the elements of rules, tool, and goals, escalate challenges to increase the risk to elicit achievement.

Hirumi et al. (2017) shares in this third installment of a series, the development of the NERVE Learning Center. The NERVE Learning Center developed virtual simulations to assist medical students as they worked through patients with cranial nerve disorders. Since patients with cranial nerve disorders are rarely seen, trained doctors are at a loss as to how to diagnose and treat these patients efficiently due to their lack of experience. The computer simulations give medical students opportunities to interact and examine patients to experience various cranial nerve disorders.

In veterinary medical training, the use of problem-based or scenario-based learning is coming into the forefront to engage the learner because the scenario or problem is based on cases they could potentially see as veterinarians or technicians. Providing background on the benefits of experiential learning to make the content relevant to the cases they will see after graduation. The virtual simulation patients in the article each have a built-in history and symptoms, which creates the patient story and engages the learner. The research and development methods combined with the three principles of experiential learning (framing, activating, reflecting) and InterPLAY (story, game, play) provides the foundation in this article of how to design case scenarios, so they offer a memorable and meaningful learning experience.

Inquiry-Based Learning (IBL)

Within the literature reviewed for this paper, there was mention of the relevance of inquiry-based learning (IBL) when compared to CBL. IBL is defined by Ungvarsky (2019) in the Salem Press Encyclopedia as an education strategy that encourages a learner's ability to research a topic. When a learner asks questions and finds answers, it is believed that they will learn and retain more information. The instructor acts as a facilitator to guide and support the learner's process. Additionally, Warner and Myers (2018) note that the combination of learner curiosity that closely follows scientific method enhance the development of critical thinking skills. This approach provides flexibility for facilitators to allow learners to contribute according to their strength, which allows learners with different developmental levels and learning styles to learn together.

The literature review found that CBL has been compared to the four levels of inquiry-based learning: 1) confirmation, 2) structured, 3) guided, and 4) open. According to Thistlethwaite et al. (2012), CBL falls between structured and guided by fostering an in-depth approach to learning as they move from acquiring knowledge to reproducing knowledge, which increases meaning and relevance. Banchi and Bell (2008) describe the four levels of inquiry-based learning and apply this method to the teaching of science in elementary school students. The four levels of inquiry-based learning are: 1) confirmation inquiry, 2) structured inquiry, 3) guided inquiry, and 4) open inquiry.

Confirmation inquiry is achieved when the instructor provides the student with a question and a procedure or method. The results are known in advance by both the instructor and the student. The goal is to reinforce a previously introduced concept and provides the student with the experience of conducting an investigation. Structured inquiry moves to the next level as the student who has been presented with a question and procedure now has to provide an evidence-based explanation. Guided inquiry moves to the next level as the students are provided with a research question, and they design a procedure or method to test their research question and resulting explanations. Instructors guide to ensure that the student's investigation plan makes sense. Open inquiry is the highest level. At the open inquiry level, students develop a research topic, design questions, design the investigation, carry it out, and present their results. Having experience in the previous three inquiry methods provides the best potential for student success using open inquiry. As students experience multiple levels of inquiry they will develop an understanding of the scientific method.

A correlation can be made between CBL and inquiry-based learning. Students must make the connection between a medical concept that was learned and a patient case. Does the medical concept make more sense when paired with a patient case? What questions must be asked to ensure the concept and the case complement each other with evidence-based support? According to the Centre for Innovation and Excellence in Learning (2016), CBL is categorized as an inquiry-intensive practice as learners analyze specific cases or scenarios in an interactive learner-centered atmosphere to analyze and address problems and resolve questions. Inquiry-based learning does merit further research as a foundation of CBL.

What Makes CBL Successful?

Authentic Learning Environments

A commonality between CBL, PBL, and IBL is the idea that learning is best done through experience. Pearce (2016) explains that learning should be designed to be meaningful to ensure students are active and engaged in the process. When one examines the constructivist learning environment, Jonassen (1999) notes that knowledge is constructed and interpreted by the individual. Therefore we know from research that experiences facilitate knowledge construction.

Authentic learning is based on the apprenticeship model where the learner works side-by-side with an expert to learn the skills they need, and as previously mentioned, mirror the complexities and ambiguities of real life. Herrington and Kervin (2007) explain the influence of cognitive apprenticeship as a method to assimilate students into authentic practices through activity and social interaction. Agreeing with Herrington and Kervin is Pearce (2016), who described the below-mentioned characteristics of the authentic learning environment.

- Providing authentic activities using examples from real-world practices to illustrate the concept being taught. These activities should promote engagement and motivation through a sustained and complex learning environment to reflect the way the knowledge will be used.
- Giving access to expert performance and allow the modeling of processes. This objective can be achieved through a skill demonstration given by an expert.
- Providing multiple roles and perspectives. Rather than having a single perspective, the learner should have the opportunity to investigate multiple ideas. Learners can then choose the perspectives that are most relevant to their needs to answer the question, solve the problem, or complete the project.
- Supporting collaborative construction of knowledge. Working in small groups helps the learner improve communication and collaboration skills as they articulate their progress with the lesson.
- Promoting reflection. The authentic learning environment provides opportunities for learners to reflect on a broad base of knowledge to solve problems. Reflection requires the same cognitive processes as scientific method – predict, hypothesize, and experiment.
- Promoting articulation. When learners are working in a group, the confidence of being able to articulate the nuances of the topic builds confidence. Confidence comes through being able to negotiate and defend their developing understanding.
- Providing coaching by the instructor or facilitator. The instructor or facilitator provides skill strategies and resources to get the learner started with the project. As the learner

builds their resources and can focus on the needed resources, coaching and support should lessen.

- Providing authentic, integrated assessment of the learning within the tasks. Traditionally, learners are assessed with tests and quizzes. In the authentic learning environment, assessments are integrated at all phases of the project as the learner performs each task. These assessments can be in the form of self-assessments, portfolios, or journals.

In CBL, the focus of the learning environment is the problem, question, or project. Using related cases that support understanding can suggest possible outcomes. Authenticity automatically relevance to the learning journey by encouraging engagement and intrinsic motivation through mirroring the complexities and ambiguities of real life.

Relevance and Retention

CBL is commonly used for higher-level courses in both veterinary and human medical education. Real-life scenarios such as those used with CBL can help conceptual knowledge development along with promoting clinical thinking and knowledge retention by facilitating meaningful schema development. Lastly, Malau-Aduli, et al. (2013) recognized that the value of CBL lies in the human capacity to learn from stories.

When looking at the importance of relevance, does relevance impact retention? An article by Bernard (2010) noted that according to research, relevant, meaningful activities that engage students emotionally and connect with their current experience and knowledge help build neural connections land long-term memory. In an earlier study on knowledge retention, Semb, Ellis, and Araujo (1993) found that the type of task affects what is learned and what is retained. Verbatim recognition, comprehension, and mental skills tasks were retained better than were recall tasks. Many studies hypothesized that case-based learning would be well received and an effective supplemental method of learning and showed an increase in learner retention.

McFee, Cupp, and Wood (2018) compared the effectiveness of CBL in traditional laboratory exercises. The results of this study showed students preferred the CBL method as it provided clinical relevance. Additionally, this study showed that providing relevance has been shown to improve knowledge retention. Through additional testing, retention was documented at one month and six months compared to retention from lectures only. Malau-Aduli et al. (2013) and Kulak, Newton, and Sharma (2017) explained that demonstrated relevance and the applicability to the topic being taught to the clinical situation would foster retention through the cognitive processes associated with meaningful learning.

Irrelevant materials encourage surface learning, which is not retained as effectively as deep learning. The knowledge that is not of use clinically becomes inert and inaccessible in memory. In the previously mentioned studies, there was a significant effect of CBL on knowledge retention, as evidenced by improved scores on retention tests. When surface learning is compared to the deep learning exhibited when the CBL approach is used. Therefore the examination of research for this topic suggests positive results about the benefits of the CBL approach but also warrants continued investigation on its impact on knowledge retention.

Collaborative Case-Based Learning

In the literature, many of the studies provided CBL in a collaborative environment where groups of students work together to assess, diagnose, and prognose a patient case. In her chapter on collaborative problem solving, Nelson (1999) explained that the factors that encouraged the use of collaboration are PBL and cooperative-based learning. Cooperative learning provides the necessary guidelines for instructors to organize learning groups and how to support learners through the collaborative process.

Medical educators are challenged to find active learning activities to help students understand concepts for application once they are out in practice. Feingold, et al. (2008) noted that learners recognized the relevance of these concepts to clinical practice. The learners in the study realized that collaborative learning helped to support the need for increased individual accountability in their learning and also found learning value when discussion between peers was involved. Also, collaborative learning allows the learner to internalize a new reality instead of passively receiving information through a lecture. The results of this study and the later studies of Hilvano, Mathis, and Schauer (2014), and Krupat, et al. (2016) showed that collaborative learning developed the soft skills needed for integration into clinical practice which include: 1) development of critical thinking skills, 2) clinical decision making, 3) refine interpersonal skills and 4) demonstrate accountability.

Conclusion

While the literature shows the benefits of CBL to the preparation of veterinary medical students and medical students in general in terms of developing the soft skills they will need once they are out in clinical practice, most of the literature found gaps in the review literature and study results. Thistlethwaite (2012), while demonstrating the benefits of CBL, concluded that while many of the articles available on CBL show an increase in student learning and preference, there is little evidence relating to its effectiveness in achieving learning outcomes in medical education. Additionally, the studies presenting evidence were patchy and inconclusive. In light of the Thistlethwaite study, it was crucial to follow articles that were written after 2012 to see if the research methods changed in comparison to the 2012 study. The articles examined after 2012 that focused on case-based learning still show positive results in learner engagement, intrinsic motivation, and the impact of relevance on learner retention.

Veterinary medicine education begins with the teaching of basic medical concepts such as anatomy and clinical pathology, which provides the foundation for all patient workups. The use of relevant real-life experiences improves learner retention as they can see how these basic medical concepts play a role in the case presentation. CBL has been shown to provide relevance to real-life experiences a veterinary learner will have out in practice. Case-based instruction can be delivered to a single learner as an exercise or as a collaborative learning experience with peers. While research studies need to continue and follow a more stringent evidence-based protocol, CBL, as part of the learning process in veterinary medical education, plays a beneficial role.

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