Cognitive Apprenticeship in Virtual Learning

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EDET 709 J50/061, Learning Theories

February 17, 2021

Abstract

Completing a formal education does not mean that learning stops. Careers often demand a continuation of learning, perhaps not formally, but through the development of knowledge and skills specific to the line of work one chooses. The cognitive apprenticeship framework was originally theorized in the 1980's and intended for classroom setting. Since that time, the internet has created new avenues for education. This research explores the application of the cognitive apprenticeship instruction theory and its application to virtual learning.

Keywords: Cognitive apprenticeship, virtual learning

Cognitive Apprenticeship in Virtual Learning

Administrative employees of municipalities, especially small rural municipalities, could potentially benefit from education focused on risk management and safety programs, specifically geared toward managing the risks associated with local government. Municipalities are often limited on resources and sometimes unable to recruit individuals with the proper background or education to manage risks for their town or city. The Municipal Association can make an impact in providing education to employees of local governments. With limited resources, online learning would be the most efficient way to deliver a learning program to municipality employees. Technology provides a resource to help overcome the budgetary, location or time challenges (Rodríguez-Bonces and Ortiz, 2016). While a viable solution, some theorists argue that online learning content is rarely designed using learning theories and when compared to classroom instruction development, a different set of skills are required to develop online content (García-Cabrero et al., 2018; Boling, Hough, Krinsky, Saleem & Stevens, 2012). Farmer, Buckmaster and LeGrand (1992) opines the development of online instruction requires proper research to ensure content is designed using an evidence based, proven learning model. Online training and education in the workplace should be designed using a proven concept for learning. As Collins, Brown, and Newman (1989) pointed out, apprenticeship learning is appropriate when a specific skill is needed to complete the required task. This research paper explores the application of cognitive apprenticeship theory in creating virtual learning to potentially be used in a work setting. This paper will outline the cognitive apprenticeship theory. Next, two case studies will be presented using cognitive apprenticeship model to implement online learning, along with an examination of each to explore the benefits and challenges. And finally, it will

include recommendations related to overcoming the challenges presented in the case study findings along with next steps.

Theory

The cognitive apprenticeship theory stems from traditional apprenticeship whereby a novice learns a skill or craft from an expert craftsman, such as a cobbler or blacksmith, by watching and doing. Cognitive apprenticeship differs in that it is based on the thinking or decision-making process, which is not as apparent as watching a practical skill; therefore, the goal of cognitive apprenticeship is to make the thinking process observable both to the student and teacher (Farmer et al., 1992; Chan, Miller, & Monroe 2009; Collins, Brown, & Holum, 1991). Collins, Brown and Newman (1991) established a framework for designing learning environments which includes content (types of knowledge required), method (ways of encouraging expertise), sequencing (ordered instruction) and sociology (social characteristics of learning environment). These are discussed in detail in the following sections.

Content- Types of Knowledge

Collins et al. (1991) noted that there are four types of knowledge that demonstrate proficiency in a learning environment based on cognitive apprenticeship and can be described as follows: *domain knowledge* includes the direct information including facts and descriptions of procedures in the specific field or specialized area, *heuristic strategies* are approaches considered to be “tricks of the trade”, *control strategies* is the knowledge needed to know when to make adjustment or change course in problem solving (also known as metacognitive strategies), and *learning strategies* are those for learning any other kinds of content.

Methods – Teaching

The six teaching methods in the cognitive apprenticeship theory are modeling, coaching, scaffolding, articulation, reflection, and exploration (Farmer, Buckmaster, LeGrand 1992; Chan, Miller, & Monroe 2009; Collins et al. 1991). Traditional apprenticeships used modeling, scaffolding, and coaching and these are core to cognitive apprenticeship (Kirschner and Hendrick, 2020; Ghefaili, 2003). According to Collins et al (1991), in modeling, the expert or teacher explains in detail the thought process involved in carrying out a task; and scaffolding is providing support to the learner. For example, if a student knows part of a solution to the problem, scaffolding occurs when the teacher helps fill in the gaps for the learner or helps solve the parts of the problem that the learner is not able to solve. Coaching, as described by Ghefaili (2003), is when additional attention is given to the learner who is asking for assistance or is having difficulty. Fan-Ray, Gwo-Jen, Szu-Chuang, and Chen (2012) describe articulation as giving the student the opportunity to convey and relate their way of thinking; reflection as allowing the student to compare their thoughts with those of others; and exploration as allowing the student the autonomy to explore the learned skills to promote a deeper understanding.

Sequencing - Instruction Ordering

Sequencing is the ordering of learning instruction has been classified as a type of scaffolding by other authors (Lang and Costley, 2019) and includes global before local, increasing complexity and increasing diversity (Ghefaili, 2003). G*lobal before local* suggests that the learner should understand the entire idea as a whole before executing the parts (Collins et al., 1991). *Increasing complexity* recommends that the teacher begins with simple tasks and then progresses to more complicated tasks. *Increasing diversity* suggests providing practice in a variety of situations to broaden use (Ghefaili, 2003).

Sociology - Social Learning Environments

This dimension of the framework of Collins et al. (1991) is related to the sociology of the learning environment. *Situated learning* – students learn in the context of carrying out tasks and problem solving in their day-to-day environment. As it is related to education in the workplace, this aspect is critical since the learner will apply learned skills to new problems. *Community of practice* refers to the learning environment of the student, giving him the opportunity to actively participate and communicate in the content being learned (Collins et al., 1991). In online learning, communities of practice can be established by using technology and a platform for peer interaction which provides the learner support and promotes a deeper level of understanding (Tilley and Callison, 2007). *Intrinsic motivation* is created when students set individual goals to grasp knowledge and skills following through with learning tasks without any external rewards. The final social learning environment considered in Collins et al (1991) framework is c*ooperation,* which is having students work together promoting group problem solving.

Exploring virtual learning in a professional environment using the cognitive apprenticeship model seems appropriate since abstract concepts that require decision making are being taught. The goal of cognitive apprenticeship model is to make the thinking process visible (Collins et al., 1991) and for the instructor or facilitator to situate abstract thinking and relay the relevance of the content to the student in a way in which they can relate (Chun-Yen, Brady, Tai-Chu, & Jin-Tan, 2012).

Cases

The research in this paper is to explore the effectiveness of online instruction using cognitive apprenticeship in a work setting. While the case studies reviewed are not the same generalized content, the focus is on the context of the application of online learning using the

cognitive apprenticeship model. Two case studies were reviewed; both are in a higher education settings and both are outlined with a summary, the results, and the challenges of each.

Case 1 - Creating Online Interactive Instructional Modules

In the first case, Moradi, Liu, Luchies, Patterson, and Darban (2018) explored the effectiveness of online instruction in basic mathematics and physics for engineering students using the cognitive apprenticeship model. Participants were students enrolled at a midwestern university and the study lasted for a 10-day period. There was an intervention group and a control group, and both completed a pre-test prior to the study and a post test at the end. The control group was given video instruction; however, content did not model cognitive apprenticeship theory. All learning content created for the study was provided on the university's learning management system. Participants were given the opportunity to complete a survey at the end.

Using the cognitive apprenticeship model, the videos developed for the intervention group gave a verbal explanation of problem solving and was synchronized with the exact words contained in the video. The concept was explained step by step. Also, examples were solved with a verbal explanation of the thought process in solving the problems. Questions were posed at the end of each chapter and immediate feedback was given. Once the student completed a chapter, they could progress to the next.

The age distribution of the participants reveals that 80% of the intervention group were 19 or 20 years old and 73% of the control group were 19 or 20 years old. The following table outlines the comparison of the participants' performance pre-test and post-test.

Table 1

Comparison of participants' performance in pre- and post-test

	Increased Score	Decreased Score	Same Score
Intervention	43%	14%	43%
Control	18%	59%	23%

As the table demonstrates, the rate of increase is higher in the intervention group. The intervention group has a greater number of participants with an increased score, as compared to the control group. The survey results of the intervention group participants were mixed. 28% of the participants preferred the video over lecture and 72% were either neutral or against the videos over classroom instruction, even though test score were higher. Overall, 70% recommended future use of the online instruction to supplement classroom lecture. Based on the results of the study, the participants preferred a blended approach to their study to include lecture and online instruction (Moradi et al., 2018).

Though the case study was structured using cognitive apprenticeship, the authors report did not substantiate thoughtful consideration of all four dimensions of the learning theory – content, method, sequencing, and sociology of the instruction. In addition, participants were surveyed post study, but the teachers or experts were not.

Case 2 – Design of a Learning-Centered Online Environment

In the second case, García-Cabrero et al., (2018) studied the implications of the development of an online learning environment using cognitive apprenticeship. The case was a two-semester project based educational program evaluation course for graduate level students in a research-intensive university in Mexico City. This study was intended to focus on their profession. Twenty-one students participated and the class met in person once weekly and met with their project team online at scheduled times. This study was intended to improve online instruction.

In phase one, the online content was assessed by asking the participants what they found useful or inadequate in the online course material and if it improved the learner's performance. The students were prompted to share their process of thinking by videoing themselves while verbalizing their thoughts as they worked through the tasks. The study showed an improvement in test scores; however, key objectives were not attained by the learners as noted by analysis of the think aloud video sessions. Student feedback was that they needed a deeper level of understanding. Participants also found difficulty with the sequencing of the content. The study found that the content failed to provide the key support the students needed.

In phase two, the case focused on the question, what key elements are needed to design a learning centered online environment. Consequently, improvement opportunities were identified, and revisions were made to the content. Initially, content was delivered using PowerPoint presentations, lecture notes, quizzes, and additional readings. An outcome of phase two was the development of an expert workshop that resulted in three recommendations: instead of content being in its current form, situate knowledge by presenting case studies with the experts modeling the thought process. Next, the virtual learning environment should support scaffolding among the students for more complex tasks and the experts suggested the use of a blog instead of a discussion board for the learner to post weekly reports so that their peers and instructors could share feedback. Because the university's learning management system could not accommodate these recommendations, a website was developed in the Weebly webpage environment.

In phase three, a virtual learning environment was created using a reconceptualization of the cognitive apprenticeship model. The experts recommended the development of a virtual learning environment that is "highly constructivist" and provided interactive online tools for

modeling and reflection. The experts assisted the designers in identifying the content knowledge, heuristic knowledge, control strategies and learning strategies.

Phase four explored the question: "Did the virtual learning environment adequately and effectively cover the materials needed by the students; and did use of the virtual learning environment lead to improvement in student learning over the online course material?" This phase validated the virtual learning environment by the experts' feedback of the content and the students' level of achievement. Results of the analysis showed that students using the virtual learning environment made significantly greater improvement in performance over those students who used the online course material.

Students who participated in the newly developed virtual learning environment experienced a 44% improvement in average scores from pre- to post-test. The virtual environment was designed implementing each of the dimensions of Collins et al. (1991) cognitive apprenticeship framework.

This case study was professionally researched, thoughtfully designed, and well developed. Though the authors discount their own successful results by reporting the participants (graduate students) may be intrinsically motivated more than others. Overall, implementation of this virtual learning environment proved to be successful with this group.

One challenge noted by the authors is that it cannot be generalized to all areas, since its development is for a specific area of study. And not noted by the authors, another challenge that may exist is the lack of financial and/or IT resources.

Recommendations

In case study one only 28% of the students preferred the videos over lecture. Though their test scores were higher using online learning, student satisfaction with the material was

lacking. When developing the content in case one the primary focus was creating videos using the modeling teaching method. The leaders of the study did not seem to consider the cognitive apprenticeship theory in much depth or make connections to previous studies or literature. As Boling et al. (2012) spells out, "According to cognitive apprenticeship model, there are four dimensions that constitute any learning environment. These dimensions include content, method, sequencing, and sociology" (2012, p. 120). Consideration of all dimensions in the development of content would perhaps help improve the content, thus positively effecting student feedback. For example, scaffolding could have been used to promote more student interaction and support. As revealed in other studies, courses that had limited interaction with others were less helpful and caused the student to feel disconnected (Boling et al., 2012).

Several authors, including Fetherson (2004) and Oliver (2002) have pointed out that developing and teaching online courses require a unique set of skills and teaching online requires different pedagogy (as cited in Hardy & Bower, 2004; as cited in as cited in Boling et al., 2012). The shift from in person to online instruction requires the teacher to take on the role of a mentor, coordinator, or facilitator, and not a transmitter of information (Boling et al., 2012). The first case study did not consider the perspective of the expert throughout the study, only the test scores of the students and their post study perspectives were considered to measure the success. The study did not involve teacher interaction with the student. Perhaps a future study should consider the performance of the expert or even feedback of their experience to improve the development of instruction. In addition, cognitive apprenticeship focuses on the instructor or instruction guiding the student through the learning. Involving the teacher in a future study would be beneficial.

The second case study did not present as many challenges at the first. Although Collins et al. (1991) did not place the components of the cognitive apprenticeship model in any order, developers of the virtual learning environment strategically used a top-down approach (García-Cabrero et al., 2018). The success of the study can be attributed to this. Each dimension was address through the phases. As the authors of the second case study noted, the virtual learning environment cannot be generalized and used in other domains. For the sake of this research the context of the virtual learning environment would likely be as successful in other areas of study using the same thoughtful approach addressing each of the dimensions of cognitive apprenticeship – content, sequencing, method, and sociology.

The final challenge that may exist is the financial component. Designing an online learning environment could be costly and require IT resources; these issues may pose a challenge for some. Further research is needed to determine how cognitive apprenticeship can be applied in the design of instruction that will take into consideration the content, methods, sequencing, and social learning environment.

Conclusions

With the advancement of technology, the demands of development of online virtual learning are increasing. The transition from classroom learning to online learning where the instructor is not physically present requires a shift in thinking when developing content (Carcía-Cabrero et al., 2018). Research indicates that cognitive apprenticeship has been used in areas such mathematics and physics (Moradi, 2018), and higher education (Bolling et al 2014) and even in corporate training (Chan et al., 2009). Professionals are often required to have a deep understanding of abstract information to develop the skill of critical thinking and carrying out tasks that require problem solving. Therefore, an argument can be made that the development of

online learning could be used successfully in a workplace setting when content is focused in a specific area, using cognitive apprenticeship. Online learning offers an added benefit of allowing the student to learn at their individual pace and while working.

This paper reviewed the dimensions of the cognitive apprenticeship theory and its application to online virtual learning. Two case studies were explored in which both applied cognitive apprenticeship to online learning. Results and challengers have been presented, along with recommendations. For additional information about the application of cognitive apprenticeship in distant learning the reader can view: Levin, J. & Waugh, M., (1998). Teaching Teleapprenticeships: Electronic Network-Based Educational Frameworks for Improving Teacher Education. Internet Learning Environments,6(1-2), 39-58. https://doi.org/10.1076/ilee.6.1.39.3612

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