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Introduction of technology into workplace and the need for change in pedagogy

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Abstract

In recent decades, workplaces have undergone numerous changes. These changes are due to the introduction of new technologies to workplace. In this paper we report a study in the maritime vocational setting. My study reveals that the introduction of new technologies into the ship environment and automation also leaves limited visible traces for the trainees to learn the job through pure observation at work. As a consequence, new learning and curriculum theories need to be applied to the current vocational education and training system to adapt them to the novel context.

Keywords: Vocational education; cognitive apprenticeship; maritime education and training; technology; workplace training.

1. Introduction

Until recently apprenticeship was the most common means of developing maritime competencies (Hutchins, 1995). Apprenticeship training fosters learning skills and knowledge in its social and functional context. It engages beginners in the field to work under the supervision of an expert. This allows them to gradually appropriate various elements of the disciplinary knowledge, skills and competencies. In recent decades work places have continually undergone environmental changes. These changes are brought about through introduction of IT by electronic equipments and automation. The introduction of the new technologies has changed the way that the work has to be performed. The introduction of any tool may eradicate the human actions and processes whose work is done by that tool. It also affects our behavior, as we have to perform new actions relevant to the use and control of the new instrument. Furthermore the tool modifies the mental processes for doing the job as the use of tool recreate and restructure the whole organization and the processes of work. Drijvers and Trouche (2008) argue that the use of artifact shapes the thinking and cognitive processes of the user. These resulted in change of context, culture and practice in the workplaces. Furthermore the way that the practitioners use the tool is based on their knowledge and conception of the tool. Consequently the way that the users use the tool shapes its functionality and fashion its identity on the work—e.g. use of computer as a learning tool vs. a game machine. Thus there is a dialectical relation

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between the tool and its users. Tool gives shape to the mental processes of the user and the use of the tool gives the tool shape, meaning, and value (Hoyles and Noss, 2003).

A significant feature of these new tools and technologies is the invisibility of its work procedures and the mental processes of its operator while working with the instruments. As workplaces become increasingly organized around IT systems, the tendency is for disciplinary knowledge and mathematical processes to become less visible when they become performed by IT (Bakker et al., 2006). Consequently new technical work environments provide limited resources for the newcomers to understand practice and become competent. In these workplaces—in Lave and Wenger's (1991) term—apprentices might be able to legitimately participate in the community's practice but they do not have access as peripheral participants to the work. On the other hand recent theories of learning and cognition provide evidence that learning knowledge out of context of its use in schools would not provide practitioners with the ability to use the required conceptual knowledge in the workplace. To understand the acquisition of discipline-based knowledge while mariners come ashore to take courses that allow them to upgrade and move up the ranks back onboard ships, I conducted a research. This research is based on a two years ethnographic study in a maritime vocational institute in Canada.

2. Framework

An alternative approach is necessary to provide newcomers with the theoretical and conceptual knowledge that cannot be acquired through traditional apprenticeship in today's technological workplace. Current theories of learning at workplace such as communities of practice provided us with the insight into the elements of traditional apprenticeship and the processes of authentic learning. Based on these understandings Collins, Brown, and Newman (1989) introduced the concept of cognitive apprenticeship, which implements the principle of learning in traditional apprenticeship to learn disciplinary knowledge in context. The concept has been presented as a way of replicating the critical elements of traditional apprenticeship for the learner in school environments (Brown, Collins, and Duguid, 1989). In this method, the teacher employs the structures and methods of traditional apprenticeship, which includes modeling, mentoring, coaching, and fading. It asks the teacher to goes further and includes articulation, reflection, and exploration of ideas to effectively guide student learning (Collins, Brown, and Holum, 1991). Like traditional apprenticeships, cognitive apprenticeship allows the teacher to model practitioners' behaviors. One of the important elements of the traditional apprenticeship is the availability of the process of performing a task for the apprentices to observe. Use of technology or performing higher-order cognitive skills, which requires disciplinary knowledge are some tasks that are more internalized and do not leave visible clues. As applications of this kind of knowledge are through thinking and cognition, learners cannot observe the application of the knowledge. Likewise there is no access to learners' cognitive processes when learning disciplinary knowledge and application of that knowledge. During cognitive apprenticeship these processes can be externalized by bringing them into the open and letting the unobservable aspect of cognition and theory appear to students at the time of its use.

In my research I studied different categories of courses that were offered to mariners who have returned to college for upgrading purposes. The analysis of my data show that those courses, which included the elements used in cognitive apprenticeship, resulted in the higher success rate of students in developing competencies needed onboard ships. Using this concept, in this paper, I present the analysis of the elements of a technology course presented to the maritime practitioners, which consider by students and the teacher to be very successful in reaching its objectives, to show the rational for its success. The course that I discuss in this paper (Simulated Electronic Navigation course) is to familiarize mariners to the electronic equipments that introduced into their workplace. The course's objective is to provide the participants the knowledge and skills in use of electronic equipments, which is used as navigational-aids onboard ships—e.g. RADAR. This course is using the real and simulated electronic equipments to provide an environment for mariners to develop skills and competencies they need to operate these equipments competently at work.

3. Collective approach to learning and problem solving

The teacher was constrained by the criteria of national marine administrator in designing the course to be able to receive approval for delivering the course. But based on his extensive experience as a marine practitioner and a maritime instructor he developed his own pedagogy. He provides the participants the course content, its detailed objectives, and delivering schedule much before the course begins. At the start of the course he explained the detailed objectives of the course, how they will approach it and the steps they will take, why each step is important and its relation to the next step, and what would be the resources available to the participants. The resources he provides are varied and includes; actual equipment, simulated software, textbooks, students manual, internet resources, field trips to different ships, and himself as an expert practitioner.

From the start of the course the teacher divides the participants into groups. He promotes collaboration and active participation of students. Groups not only increase knowledge sharing and participation of its members but it gives rise synergistically to ideas and solutions that would not come about without it (Schoenfeld, 1989). The teacher arrange for students in the groups to be actively engage in their own learning. Early in the course, he familiarizes the students with all the electronic equipments, which included in the curriculum. He describes their functions and demonstrates how the instruments operate. The students' task is to learn and be able to demonstrate to the teacher how to use each one of the equipments competently. He passes part of the responsibility of students' learning to them. The students have full access to the teacher as the expert operator, to the equipment itself, simulation software, their peers and other resources. They could decide the pace of their learning and use of those resources.

3.1. Accommodating elements of authentic activity

The teacher designed the course to include elements, which is necessary for students to experience the culture through participation in authentic marine activity. Simply defined, the authentic activities are the ordinary practices of the culture (Brown, Collins, and Duguid, 1989) and so it should include its essential elements. The teacher adjusts the course objectives for the parts of the syllabus, which is not compatible with the current practice of the domain. Also he includes equipment that is in use and consider as important part of the marine culture, although it is not originally part of the curriculum.

3.2. Participation in the Culture

The teaching starts by providing *modeling in situ* and *scaffolding* for the participants in order to introduce them to an authentic marine activity. Instead of using a well defined example, from the textbook, as a way to introduce a practice—RADAR plotting procedure in this case—the teacher uses the real equipment (simulated) to produce data. He projects the RADAR display on a big screen to be visible to all participants. He then designed a simple scenario similar to everyday life at sea. He explains the context of the exercise and asked participants to predict the results, based on the available information and raw data that they could get directly from the RADAR equipment. He verbalizes and describes the entire problem-solving procedures while doing the task thus to make available to the participants, his—the expert—cognitive processes. He runs the equipment in real-time and starts solving the problem. He then uses an overhead projector to project his work sheet, in order for the participants to be able to see how he process the data and calculate the result in real-time. When he is done with the first part of the procedure and is waiting for the second set of data to be extracted in an specific time period from the RADAR—as it is in real condition onboard ship—he articulate what he has done so far and explained what would be the next steps. He then continues with working on the problem to the end of the process. It was the first day of the course and he was modeling the problem solving in the context of its use—at least as close as possible regarding timeframe and source of data. In the morning they discussed the principle of how the RADAR equipment work and what is the nature of the information it provides. In the afternoon students observing the use of the equipment by a practitioner. In a sense he was making visible what was invisible if they would have observed a practitioner onboard a ship working with a RADAR. The act of making visible achieved in twofold, one with the cognitive activity of the practitioners working with electronic equipment and second with the function of the equipment itself—as he taught the working principle of the equipment beforehand. The teacher then assigns a period of time for question and discussion. He then uses the simulator equipment to calculate the information and then compares the results with what they already calculated. There are small differences—as it happens in real situations. They discuss why there is a difference—the accuracy of the instruments and method they used and how it may affect their decision making onboard ship. It gives the students an indication of the processes of problem solving in a real context. The teacher then runs another exercise but this time asked the participants to do the process at the same time that he is doing it.

The teacher *coaches* the students thus they gradually gain more self-confidence and control. The coaching *fade* as the students develop competency and move into a more autonomous phase of collaborative learning, where they start solving the problems on their own and participating consciously in the culture. The teacher assigns part of the class time for students to work on the problems at their own pace and encourage the students to collaborate. They gradually build up a social network within the culture, which in turn helps them develop its language and the behavior. In short it promotes the process of enculturation. As the students collaborate they engage in *articulation* of their problem solving strategies. They also *reflect* on their practice by comparing their own with their peers and the expert—the teacher—practice. This in turn leads to learning and developing competencies in a marine context.

3.3. Extending the Classroom Activities to the Field

During the course the teacher arranged for a series of field trips for participants to experience the marine culture and the real world practice onboard ships. In each field trip the students attend different types of ships from various sector of the marine industry. The main purpose is for the participants to get familiar with a variety of navigational equipments onboard different types of ships and observe operation of those equipments in the context of their use by expert practitioners. It had a great impact on the students learning as it is noted in their interviews: 'It was good to get actually on the boat that has everything that we have been talking about and just kind of have a look at how it all works together' (John).

The field trips have a great impact on the students' perception of the use of the equipments and increases their competency in the future use of these equipments onboard ships. It helps them to have a deeper understanding of the culture and context of ships and use of the equipments in real life operation. Field trip practice is in sync with the cognitive apprenticeship method in providing the learner the context of practice. The difference in practice is, instead of bringing the context into classroom, field trip takes the classroom participants to the context.

3.4. Bringing It All Together

As the course advances, students become familiar with the principal of the equipments and their use in practice. At this stage the teacher moves the teaching practice into the next level. He assigns a section of the lab as the simulated bridge of a ship with its entire equipments and other resources available to a mariner. He assigns each group of students the duties of members of a ship's navigation team. He give them specific task and run the simulator in real-time. His aim is to create an authentic marine environment—as far as practicable—for the participants to practice in the context. He acts himself as the master of the ship—as he is in real life—and supervises the activities of the team. His supervision faded quickly as the teams were showing confident and competency in doing the tasks. The participants are deeply involve in the tasks and in constant collaboration and sharing their expertise. It is then that they, like any apprentice onboard ship, recognize and solve the ill-defined problems that issue out of the authentic activity. The tasks are not well-defined exercises that are typically given to the students in school and on exams. My observations show that the participants do not behave as students, but as practitioners, and develop their conceptual understanding through interactions and collaboration in the culture of the workplace.

3.5. Debriefing, a Venue for Articulation and Reflection

After each exercise the teacher requests each group to *articulate* and then *reflect* on their exercise through a debriefing session. "Articulation includes any method of getting students to articulate their knowledge, reasoning, or problem-solving processes in a domain" (Collin, Brown, & Newman, 1989, p 482). It favors the debate among the team members and brings to open and make visible the cognitive processes in problem solving of each member of the practice—it would have been more effective if the rest of the class participated in the debriefing of other groups. It allows new relationship to develop between the members and with the teacher. It also permits the teacher to monitor the process of learning skills and the developing competencies of each participant.

The ability of the navigation simulators to replay the exercise is a great asset for the participants to be able to reflect on their practice through reviewing and comparing their problem solving processes with their peers and mainly with their teacher as an expert. Simulators are able to highlight the determining feature of the students' performances. This makes it easier for the participants to gain conscious access to their problem solving strategies.

4. Conclusion

The analysis of my data showed that this course, which included the elements similar to cognitive apprenticeship, methods resulted in creating a sense of confidence in participants and believes that they have acquired the skills and competencies needed onboard ships to act competently. My follow-up interviews shows that the participants are satisfied with the course outcomes. It enhanced the ability of students in understanding the disciplinary knowledge and its application into marine culture and practice. As one of the participants pointed out: 'you develop air of professionalism because of what you've been exposed to. This is what I've kind of taken in. I think I'm more professional' (Dave).

Although the concept of cognitive apprenticeship is originally designed for teaching children math, reading, and writing at school but my study shows that the application of this method in technology teaching in vocational education and training can effectively help practitioners in appropriating skills and competencies they need at work. Using this method for presenting technology courses have potential to provide mariners with authentic learning environment at schools, which can supplement their on-the-job training. My study showed that the application of cognitive apprenticeship in simulators, which use context physically and functionally similar to workplace, dramatically enhanced learning outcomes by allowing cognitive skills to be made visible through debriefing. Although the simulated equipments and environments are not identical to real world context of the work but it does replicate a real world scenarios. It provides the instructor and students with the extensive learning possibilities through its valuable resources. It engages students in authentic learning activities and the applications of procedures similar to traditional apprenticeship.

5. Educational significance

We conclude that vocational pedagogy using cognitive apprenticeship has to re-contextualize the field of practice itself and translate this field into curriculum. In this way disciplinary knowledge can make meaning to the practitioners of the field. Cognitive apprenticeship provides possibilities for learners to acquire disciplinary knowledge in the context related to workplace. This allows learner easier transitions and a translation of disciplinary knowledge into applied knowledge when they cross boundaries of school to workplace. Apart from use of sophisticated technologies and the tasks, which needs higher order cognitive disciplinary knowledge, most features of traditional practice in workplaces have properties that depend on particular contexts. We further conclude that vocational pedagogy also has to consider the situated knowledge that is usually closely associated with those tasks. Vocational pedagogy thus needs to consider both aspects: the occupationally re-contextualized disciplinary knowledge—which can be learned at schools—and the component of practice to be realized at workplace.

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