THE WORK, THE WORKER AND THE MACHINE: LEARNING THROUGH COMMUNITIES OF PRACTICE IN MANUFACTURING

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Abstract

This study examined the learning process associated with problem solving contexts among manufacturing workers. Using a modified critical incident method, we interviewed twenty machine operators from three organizations about problems they encountered in work. The findings suggest that learning is mediated through a triadic, dialogical relationship of the worker, the work, and his or her machine. The ongoing process of becoming a machine operator is embedded in these relationships and within a broader community of practice.

Recent changes in the nature of work and the workplace are renewing emphasis on work-related learning. Many of these changes are being implemented to help organizations remain competitive. Organizations are using formal training programs to help their workers address this need. As Rowden (1966), suggests, “a literate, educated, inquisitive, problem solving workforce is essential to the survival and competitiveness of business and industry” (p.3). The U.S. industry spends more than $120 billion annually on formal training programs and related costs (Day, 1998). Yet, the effectiveness of such training programs remains in question. Only a small minority of workers regard the knowledge and skills they gained through employers’ training programs as important (Livingstone, 2001). Furthermore, craftsman, laborers and operators are not able to use their skills and abilities within their work and are dissatisfied with opportunities to improve their skills (NRC, 1999; Freeman, 1999). Such studies raise questions about the applicability of formal workplace education and training to what it is that workers need to know.

Nowhere is this problem more evident than in the relatively new area of training for problem solving among front line manufacturing workers. As the limitations of formal training for problem solving have become increasingly apparent, more attention has turned to informal learning in the workplace and the role that the work context itself plays in developing requisite knowledge and skills among manufacturing workers. In this study, we focus on workers’ experiences of problems within the context of their work and how these contexts foster their learning and development.

Problem-solving as a Context for Adult Learning

Within the U.S., manufacturing firms are pushing problem solving and decision making to frontline production employees. They are creating formal training in problem solving, delivered through classroom-based instruction, on-the-job training, and targeted training workshops, to help them meet these “new” expectations. These training programs, however, reflect problem solving as a decontextualized, linear, and technical process, one that can be superimposed on a variety of work situations. What is taught in these programs rarely transfers to job performance (Broad, 1997; Foxx & Faw, 2000; Holton, 2000).

Such observations have led to increased attention to the role of informal learning in the workplace (Leslie, 1998; Livingstone, 2001; Marsick & Watson, 2001; Verespej, 1998). Recent empirical studies report that the majority of what employees need to know to perform their work requirements is acquired through informal learning. Although informal learning constitutes the bulk of learning that takes place within the workplace, it is the least recognized in the literature

and in practice. In part, this situation may be attributed to the little research that has been conducted on informal learning arising from problem solving among front line workers. Few studies have carefully examined the role that problem solving plays in what and how manufacturing workers learn, the nature of the learning that occurs in the production process, and the forms of knowledge derived from these experiences.

The informal learning of frontline workers occurs most often when their job scope expands to include more skills and responsibilities than they had previously performed and/or mastered (EDC, 1998). Problem solving, as a “new” requirement for frontline employees, has created a “new” space within which informal learning can be studied. With the increased need for workers to solve operational and organizational problems, it is critical that researchers understand the ways in which workers actually learning within the problem solving context. Therefore, the purpose of this study was to examine the nature of the learning process associated with contexts of problem solving among frontline machine operators within manufacturing settings.

The Methodology

This study employed a qualitative, interpretive design using a modified critical incident technique as the central research methodology. Twenty machine operators, from three different manufacturing organizations, participated in semi-structured interviews lasting approximately one hour. The basic criteria for selection were that participants were currently employed by the organization, currently working as a machine operator, responsible for solving work-related organizational and/or operational problems, and they were willing to be interviewed. Participants varied in experience level, length of employment, age and gender. All interviews took place during the participants’ workday and all participants were paid their usual hourly rate while being interviewed. Interview protocols were informed by the critical incident technique. Each participant was asked to describe in detail specific problems that they encounter in their everyday work.

A total of 70 critical incidents were reported and data from these incidents were analyzed using categorical content analysis techniques. Following a preliminary analysis of the individual interviews, eight of the twenty participants accepted invitations to participate in one two-hour group interview. The procedure used for the focus group was also a semi-structured interview. The questions used in the focus group interview flowed from the initial analysis of the individual interview data. These data were further subjected to categorical analysis and used to both triangulate the findings and to further elaborate and expand some of the categories from the individual interviews and critical incidents.

Findings

The findings suggest that the learning and development of machine operators are intimately bound up with the problems they encounter within their daily work. In this section, we summarize our findings around three two major themes: learning and problem solving, and becoming a machine operator.

Learning and Problem Solving

The machine operators’ descriptions of their work were filled with references to learning, even among those who have been on the job for 20 or more years. They find learning to be a positive aspect of their work and a positive experience for themselves personally. For example, Patty, with less than one year experience, says, “As time’s gone on it gets better and better- I have

gone home every night with a headache- but everyday is a learning experience." Even Hank, the most experienced operator among the participants with 23 years experience, said, "Even though I've run the machine for years and years, I still make a mistake- something I never thought of before and my boss helped me out. I like to learn something everyday- whether it's big or small." This observation is similar across experience levels and includes operators across the three organizations participating in this study. In fact, the 70 problem incidents produced a description of 81 various significant learning events.
It is interesting to note that we did not ask any of the participants questions about the frequency of learning. These comments were all volunteered by participants during our interviews. The frequency of learning, with no direct prompting, was also touched upon during the focus group. A focus group participant commented that, "There are all sorts of things that could go wrong. That's a learning in itself." Another said, "If you think you've learned it all, you just better get out of there." In other words, there is always something to learn no matter how many years one has as an operator. All of these comments regarding the frequency of learning and their attitude toward learning were all in response to a protocol which focused on problem solving within the context of their everyday work.

The actual problem solving process involves two major dimensions: the trigger event or the event that gains the attention of the machine operator, and the responses to the trigger event. Examples of a trigger event might include an unusual machine noise, a blinking warning light on a computer screen, or an unacceptable finished product.
Although we did not specifically ask how participants felt during a trigger event, it became clear that for many of the machine operators, the event evoked powerful emotions among the workers. Feelings of frustration and confusion were two of the most frequently mentioned emotions. Others, however, spoke of fear, anger and panic. The focus group session gave us an opportunity to explore emotion further and so we asked the question, "How do you feel when you suddenly realize that you have a problem?" Focus group members did not hesitate to offer the following descriptors- frustration, fear, embarrassment, momentary depression in that they "felt bad", and guilt as in "I feel like I've done something wrong."

After the trigger event and the associated emotions occurred, machine operators worked to resolve the problem. Their descriptions revealed several important characteristics of the resolution process. Aaron, an experienced operator, summed up the experience of most machine operators we interviewed by stating that, "I learn how to solve problems through past experience, other operators, and job training…Most of it is just from working." Machine operators across all three organizations attempted to use a variety of strategies to solve the problem at hand and/or personal strategies which allowed them to be proactive in an attempt to lessen or eliminate future problem incidents. The nature of these strategies seemed to point toward the desire for self-sufficiency. Operators were also clear about their reliance on others to assist them in resolving problems. Machine operators viewed more experienced operators as critical to their success in resolving problems, though supervisors, if they were perceived as knowledgeable about machine operations, were also sought.

Becoming Machine Operator

Learning and problem solving are perceived to be embedded in a larger, ongoing process of becoming a machine operator. For machine operators in this study, the strategies for resolving a problem seemed to depend on the experience level of the operator. For example, newcomers relied heavily upon their operator trainer when faced with a problem. Novice operators first sought help from a supervisor. If the supervisor was not readily available, the novice operator would contact another more experienced operator to assist them, followed by any co-worker

that was present during the incident. The last resort when faced with a problem was to try and figure it out for themselves. The expert operators, on the other hand, handle problem solving in the reverse order, beginning with themselves. Casey, a 30 year machinist, remembered a problem he was having with a tool. When asked how he resolved that problem, he said, “I went out and had an illegal smoke- I just sat there and I thought about it and I said, OK- you’ve got chatter. It’s got to be the tool- how can I dull that thing down? I never tried that before but it worked.” Strategies used by particular operators to resolve problems tended to depend on their level of experience.

Furthermore, new knowledge is constructed as machine operators attempt to solve problems. It is through the engagement in problem solving activity that extends and transforms the individual’s existing knowledge, evermore bringing the individual closer to becoming an experienced machine operator. As most of the problems described were technical in nature, new knowledge often came in the form of concepts and procedures. The literature refers to these two forms of knowledge as propositional knowledge and procedural knowledge (Billett, 2001). As can be expected, past knowledge gained by a more experienced operator will greatly affect the problems they face on the job. Though the vast majority of the problems operators face on a day-to-day basis are technical in nature, over half of the learning events described in association with problem solving incidents reflected deep involvement of the self and others. Machine operators in this study gained new knowledge about themselves, about others, about their organization and about learning in general through solving technical problems. This is often referred to as an individual’s dispositional knowledge (Billett, 2001). In contrast to the more declarative or instrumental nature of proposition and procedural knowledge, this latter form of knowledge is often affective in nature, reflecting not only awareness of self and others but powerful feelings about what is known.

In summary, our findings suggest that, from a machine operator’s perspective, learning and problem solving are one in the same. Problem solving activities are shaped by a desire to not only solve the problem but to regain equilibrium or certainty. This process takes place within a larger social context in which workers involve other, more experienced operators or supervisors. The learning experience results in several forms of knowledge, all which seem to contribute to an ongoing process of becoming a machine operator. The process most often occurs within a dialogic relationship among the worker, the work and the machine. Learning to become a machine operator is characterized by participation in a series of these overlapping and interacting triadic relationships, suggestive of communities of practice that define levels of participation (Wenger, 1998).

Discussion and Implications

For machine operators in this study, learning to become a machine operator occurs through solving day-to-day problems within a community of co-worker operators. This process is mediated through dialogical relationships among the worker, the work, and the machine. Operators describe the relationship between themselves, the work and the machine as explicit and personal. The learning that occurs within this dialogical relationship is informal, contextual, situated, and constructive. Workplace learning reflects a process of social participation, arising from the differences of perspective among the various operators who are co-participants in this framework (Lave and Wenger, 1991). Furthermore, as they become full members of the community of practice and as they interact with and between the dialogic relationships within which other operators find themselves, their identities are strengthened. Our data overwhelmingly supports the notion that learning is both individual and social. How machine operators experience their job, what they understand about what they do, what they know, and what they do not want to know are not simply individual choices nor are they just the result of

assignment to the “machine operator” classification. The meanings that machine operators attribute to their experiences and hence, the construction of new knowledge, is shaped by belonging to a community, but with a unique identity.

The findings of this study reinforce previous findings of the value of informal learning within the workplace and the importance of problem solving and self-authorship to the ongoing learning and development of expertise. The findings also draw attention to the powerful role of emotions in workplace learning. Yet, such learning often remains at odds with organizational practices that often structure problem solving through algorithmic and bureaucratic structures and procedures that delimit and constrain worker authority and learning. This study clearly shows, for example, that the current sequentially-based, individualistic model of formal training for problem-solving, is based upon a faulty conception of how day-to-day problems are solved.

The findings and interpretations of the data hold implications for both theory and practice. Theoretically, the findings suggest that machine operators reflect deeply upon their practice, an association too often applied only to professionals. Further, the findings confirm Wenger’s (1998) use of ‘identity’ as a pivot between the social and individual realms of the development of identity, learning and thought. This study clearly shows emotion as an integral part of learning which spans from the initial trigger event of a problem solving incident through the creation of new knowledge.

This research also holds implications for problem solving training within the workplace, the role of managers and supervisors in relation to the development of expertise, the role of the Human Resource professional as adult educator, and the role of adult educators in general. Training for effective problem solving in the workplace requires a recognition and integration of the experience and practical knowledge workers already possess with regard to problem solving skills and the socio-cultural contexts of their practice with the working knowledge required by their employers. Such a model of problem solving training resembles the integrated theme-based approach to teaching adults (Dirkx, 1997) which grounds the development of academic skills, life skills, and the processes of problem solving, learning-to-learn and critical thinking within the context of particular thematic issues of importance to the learner. One of the most currently compelling challenges for adult educators in workplaces will increasingly be to help people and organizations to co-ordinate and negotiate the working knowledge, working relationships and work practices of the workplace.

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