CONTINUING PROFESSIONAL EDUCATION

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Abstract

This case study examined the self-directed and team-based learning activities of a software quality assurance organization in central Indiana. The skills required to assure a high level of software quality evolve rapidly and software quality professionals must embrace ongoing technology and process changes. The thirty focus group participants performed a variety of quality assurance tasks including configuration management, research, automated test development, test planning and execution, and team leadership. The case study was based on semi-structured interviews of four focus groups of software quality professionals, and explored the learning styles, preferences, and activities deployed to learn new technologies and solve complex software problems.

Software products are becoming increasingly pervasive in our culture. The study of continuing education for the software quality profession is important due to our increased reliance on this profession to meet customer expectations for high-quality software products. The proliferation of software products in our culture has also increased the demand for software quality professionals. Those professionals who have access to continuing professional education to improve and maintain skills have the opportunity to meet customer expectations. There is no mandated certification or licensing for this profession therefore professionals are left to chart their own course of learning. This study sought to understand how these software quality professionals meet their continuing professional educational needs. As well, the study identified key resources required to support such continuing professional education both within the workplace and off the job.

Future study of the role of critical self-reflection in establishing learning objectives could enhance our understanding of how software quality professionals identify and plan their learning activities. Further investigation of the value of computer programming and logic knowledge to the software quality professional would benefit our understanding of baseline skill requirements for the various roles performed in the profession. There are also opportunities to engage in future action research projects on co-location of teams, mentoring, and job rotation strategies, as employees were found to learn effectively from peers.

Dedication

To my husband, Steve, and my sons John, Cameron and Andrew for their endless patience, enthusiasm, and support.

Acknowledgements

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Chapter One: Introduction

Introduction

In the past thirty to forty years, our culture has increased its dependency on software products. The examples of software integration into our lifestyles are nearly limitless. Our children play with video games, take online reading quizzes, listen to iPods, text their friends via their cell phones, and create their own pages on shared websites. They use pre-paid spending cards and credit cards, managed by parents via the web. We wake to software-driven alarm clocks, live in homes where the temperature may be controlled by a programmable thermostat, and use microwaves and dishwashers with programmed functionality. Our cars are increasingly reliant upon software modules, controls or sensors, and our dashboards reflect numerous programmable interfaces and software displays of statistics (speed, gas consumption, temperature controls, etc.). We get roadside assistance via On-Star. We grab some cash at a local ATM.

Many of us are reliant on computer systems and networks to perform our professional work, take our online classes, fly to a distant location for business or pleasure (with software-based aircraft control systems), rent a car, manage our finances, pay bills, and obtain quality healthcare from primary caregivers and hospitals (CAT scans, MRIs, patient-controlled morphine pumps). We purchase products on the Internet; the product manufacturing is likely automated and the delivery/transport is managed via software tools. Many of us have given up the telephony landline at home in lieu of voice

over Internet protocol (VOIP) or cell phones. We shop at grocery stores that use bar code scanning to manage inventory and checkout. We swipe a credit or debit card to pay for our groceries, gas, books, etc. We watch cable or satellite television and control these systems with our integrated remote controls. We watch movies-on-demand or manage our television time through a TiVo system that records programs onto local hard drives. And what about the technology infrastructure needed to provide such services? Server banks, T1 lines, digital public branch exchanges, Ethernet, wireless connectivity, automated alerts for administrators, backups and replication for disaster recovery and continuous data protection are but a few of the products required to deliver services to consumers. Database applications such as customer relationship management software, supply chain management software, secured office building access systems, business analytics for strategic planning, payroll systems, human resource systems, etc. are integral parts of our current business and government organizational operations. School systems implement software tools called student information systems to manage grades, enrollment, fund raising, special needs and No-Child-Left-Behind compliance and reporting, and cafeteria management. Teachers communicate with parents via email and post assignments and grades to web sites. Many exams such as the GMAT and GRE are taken online and can provide nearly instantaneous grading of student responses. Local 911 dispatching is managed via software applications. Insurance companies process your claims through software applications and interface electronically with the service providers and consumers. Software products impact nearly every aspect of our lives on a daily basis.

The study of continuing education for the software quality profession is important due to our increased reliance on this profession to meet our expectations for high-quality software products. The proliferation of software products in our culture has increased the demand for software quality professionals. Those professionals who have access to continuing professional education to improve and maintain skills have the opportunity to meet customer expectations.

Ginac (1998) noted that software customers "are more concerned with such things as the product's reliability, availability, performance, and the responsiveness of the company's service and support organizations" (p. xii) than they are with the processes used to develop the products. He believed that professionals who reflected on customer expectations to create specific and measurable quality requirements created good software products. Meeting quality requirements, in combination with a repeatable development process, results in higher quality software.

Background

Changes in technology require new learning by the participants and users. As a software quality professional, my educational research interest lies with those who assure the quality of software products. Software quality is an expanding and evolving profession with diverse learning needs. In addition to being the principal investigator of this study, I am also an insider to the software quality profession. I have worked for a variety of software companies in Michigan, Texas, California, and Indiana for more than thirty years. These companies have provided software products to consumers in government, education, finance, industry, and other enterprises. My predominant role is

quality management and software quality engineering. I value self-directed learning and continuing education and that is why I am studying these subjects.

I am also the Executive Director of Quality for a software quality organization of a central Indiana company that makes complex server software for the Windows, Linux and virtual operating system platforms. Thirty software quality professionals of this organization were the subjects of this study. My responsibilities include the hiring and assignment of software quality staff, developing strategies for automated testing, configuration management of the software, technical course development and writing, and management of the test lab and capital budget for test equipment. The software quality professionals are assigned to specific cross-functional project teams that are led by a project manager and also include software developers and technical writers. I work collaboratively with the Director of Development and Director of Product Management on strategic planning and resource requirements. I am also a Certified Quality Manager and Certified Software Quality Engineer with the American Society for Quality (ASQ). The certifications provide objective evidence of my knowledge of the key functions critical to the development of software products and the continuous improvement of business processes.

Problem Statement

With our increased migration to and dependency on software products and tools comes a demand that the software meets or exceeds customer expectations. Software products are an output of the knowledge industry and our shift to the information age, much as automobiles are an output of the automotive industry and manufacturing era. As

noted by Drucker (2002, p. 7), "Knowledge work is not defined by quantity. Neither is

knowledge work defined by its costs. Knowledge work is defined by its results." The

software industry contains a quality assurance profession that is instrumental to the

achievement of positive results in software development and delivery. The quality

professionals of the software/knowledge industry form a critical learning community with

ongoing learning needs.

Consumers of any technology product require high levels of performance,

reliability, and overall quality (Schulmeyer & McManus, 1999). The software quality

profession is in its infancy compared to other quality assurance competencies such as

statistical process control for manufacturing and pharmaceuticals. Quality management

focuses on the assurance that a product meets the specified requirements (Schulmeyer &

McManus, 1999). There are many assumed requirements in software quality, such as the

breadth of operating systems or computer hardware upon which a product must operate.

Software product development processes are unique to the industry and often not well

understood by software professionals. As with professions such as the law and medicine,

there are many areas beyond generalized practice in which to specialize. The use of

standardized software development processes varies within the industry (Schulmeyer &

McManus, 1999) resulting in new learning requirements for software quality

professionals when they change positions or companies.

The software quality professional must engage in lifelong learning to provide

value to the development process and assure the product outcomes are satisfactory to

customers (American Society for Quality, 2007). How do they keep abreast of the

changing technological and process landscape to meet the customer requirement for high

software quality? How do self-directed and team-based learning address the continuing

professional education needs in this field? By studying the learning activities of a

software quality organization, I have contributed to an understanding of how these adult

learners use self-directed and team-based learning to build and maintain a professional

skill set in the context of software technology and quality assurance.

Software quality assurance has not reached the level of organized

professionalization and continuing professional education that is reflected in engineering,

teaching, medical practice, or the law (IEEE, 2007). It is important to customers, our

economy, and the software quality professionals that this profession benefit from

additional research related to adult educational needs. By conducting research regarding

the continuing educational activities of software quality professionals, I have established

a baseline understanding of how professional learning needs are met in this industry.

Watts Humphrey, a pioneer in software development practices, identified a

number of common concerns related to software product quality. These concerns include

open-ended or vague requirements, uncontrolled change, arbitrary schedules, insufficient

test time, inadequate training, and unmanaged system standards (QCI CSQE Primer,

2002). Humphrey believed that poorly defined development processes and poor process

management limited effective implementation of software technology. A number of

organizations promote different software development methodologies, especially through

websites. Best practices for the profession are emphasized. There are adult learning needs

associated with learning new methods and applying best practices within the profession.

Software quality professionals come from a broad variety of backgrounds and

experiences. Based on a 2008 survey of central Indiana software quality professionals, I

have found that such professionals may have backgrounds and experience including education, graphics, geology, English, general studies, history, informatics, or math. Software quality professionals may lack traditional college-level education, with a hiring emphasis on their aptitude, work experience, passion for technology and critical thinking skills. Opportunities for continuing professional education are important to support the learning needs of software quality professionals who, in turn, assure software product quality.

Purpose of Study

This study sought to understand how self-directed learning and team-based, or group, learning activities are used to meet continuing professional education needs in the software quality field. Continuous improvement of software quality assurance skills and process knowledge is essential to achieving the goal of producing software products that meet or exceed customer expectations (American Society for Quality, 2007). Studying the learning activities of software quality professionals enhanced understanding of continuing professional education within the software quality profession. To prepare for the study, I reviewed the state of professional education for software quality assurance and related theories of continuing professional education, self-directed learning, and team-based learning (a more traditional form of continuing professional education). This study explores and describes the learning activities of software quality professionals within an organization. The participant feedback reflects how self-directed and team-based learning serve as forms of continuing professional education to enhance skill, knowledge, and competence.

The focus of the study was the software quality organization that I lead at a central Indiana software company. The organization is diverse and comprised of approximately forty employees. Both men and women are represented in the population, as are people from different cultures (including Romania, Indonesia, and Nigeria). The interview participants included software quality team leads, software quality engineers, configuration management and test automation engineers, and software quality architects. These roles, performed in a typical software quality organization, are explained in Chapter 3.

From this research, software quality professionals and adult educators can reflect on how self-directed and team-based learning fulfill continuing professional education goals. As Stanley stated, "The highly competitive nature of our global economy and the rapid change in the production process has made self-directed learning essential" (2007, p. 3). This research describes how self-directed learning and team-based learning meet the CPE needs of a fast-paced organization within an award-winning software company.

Research Questions

The research questions are:

- How is self-directed learning used in this software quality assurance organization to meet continuing professional education needs?

- What is the role of team-based learning to meet continuing professional education needs?

- What barriers or enablers to continuing professional education exist in this organization?

- Who establishes the learning objectives for continuing professional education? Are the objectives learner-centered and learner-defined?

- How are continuing professional educational theories reflected in the participant feedback on learning objectives?

I attempted to assess the balance between internal and external continuing professional educational activities. Cervero noted that, "The amount of continuing education offered at the workplace dwarfs that offered by any other type of provider, and surpasses that of all other providers combined" (2000, p. 5). If this is true, then the participant feedback on resources and opportunities provided by the organization should reflect this.

Definition of Terms

Software Quality Assurance: Kit (1995, p. 11) provided an overview of the software quality assurance function. "QA is usually defined in the literature as a function which:

- monitors the software and the development processes that produce it;

- ensures full compliance with established standards and procedures for the software and the software process;

- ensures that inadequacies in the product, the process, or the standards are brought to management's attention."

This description identified some of the complexity in a role that continually evolves along with technology. Software quality professionals must be aware of improvements to processes, changes to standards, technology shifts, and the status of the

application of processes, technology and standards to software products under their domain. The practices deployed by software professionals are meant to ensure that a software product is fit for use by the customer(s).

The American Society for Quality (ASQ): This is a national organization that promotes the professionalization of quality management services through education, community, and certification programs. The ASQ Certified Software Quality Engineer (CSQE) is a professional certification provided by the American Society for Quality. A certification indicates professional or organizational compliance with testable or auditable standards of performance. The American Society for Quality defines a Certified Software Quality Engineer as "…a professional who has a comprehensive understanding of software quality development and implementation; has a thorough understanding of software inspection, testing, verification, and validation; and can implement software development and maintenance processes and methods" (CSQE Certification Brochure, 1996). This definition lacks an integration of the scope of technological skill required to meet the objectives of the role. The certification is focused on process and methods. There is a gap in addressing software quality professionals' technical learning needs. How are these ongoing needs met?

Profession: For the purpose of this proposed study, "profession" means an occupation that requires training or study in the sciences or liberal arts with a requirement for advanced study in a specialized field (The American Heritage Dictionary, 1985, p. 989).

Quality: There are various views on the meaning of the word "quality" as it relates to software products. For the purpose of this study, I chose Garvin's user-centered

view: "The *user view* sees quality as fitness for purpose" (Schulmeyer & McManus, 1999, p. 2).

It is ultimately the user of a software product that determines whether or not the product meets or exceeds their expectations for usage. The software quality professional has the responsibility to represent the user's needs for fitness for purpose in designing test activities and advocating for product and process improvements (Kit, 1995).

Assumptions and Limitations

One of the key assumptions of this study is that self-directed learning plays a role in continuing professional education for software quality professionals. A second key assumption is that there are limited professional programs available for continuing education in software quality assurance. There is an assumption that the focus group feedback will reflect continuing professional education activity conducted within the workplace.

There are several potential limitations to be noted. As the leader of the organization, feedback will be viewed with my own lens of history and experience with the focus group participants. Some participants may be reluctant to share negative or strong views, despite the clarifications in the informed consent form. It will not be possible to assure 100% participation by the potential software quality professionals in the organization due to the inevitable persons being out sick, on vacation, or having schedule conflicts. Consequently, some important voices may not be heard. Finally, the feedback gathered reflects only one organization and cannot be generalized to other organizations or professionals.

Summary

The software quality assurance profession is currently unregulated and is not sourced from traditional higher educational programs. There are few well-defined continuing professional education programs available to the software quality professional. Yet the complexity and interoperability of software products continues to increase, making the job of assuring software product quality ever more challenging. This research study reflects on how this organization's software quality professionals meet their continuing professional education needs through self-directed and team-based adult learning activities.

Chapter Two: Literature Review

Introduction

This chapter provides an overview of prior research on the software quality assurance profession and its current continuing professional education framework. Related research on the theories of continuing professional education, self-directed learning and team-based learning provide the context for this research activity.

Software Quality Assurance

According to Edward Kit

Software testing has become a profession—a career choice—and a place to make our mark. The software testing process has evolved considerably, and has reached the point where it is a discipline requiring trained professionals…Testing is not an entry-level job or stepping stone to other things. Many people find that when done properly, it surpasses the challenge of product development. (1995, p. 5)

Kit points out that software testing "has yet to become a fundamental component of university software engineering curricula, and training in industry is improving but often haphazard" (1995, p. 7). He provided a table that describes the evolution of the software development practice over the past fifty years (Kit, 1995, p. 9).

	1960	**1970**	**1995**
Software size	Small	Moderate	Very large
Degree of software complexity	Low	Medium	High
Size of development teams	Small	Medium	Large
Development methods and standards	*ad hoc*	Moderate	Sophisticated
Test methods and standards	*ad hoc*	Primitive	Emerging
Independent test organizations	Few	Some	Many
Recognition of testing's importance	Little	Some	Significant
Number of testing professionals	Few	Few	Many

Table 1: Kit's Evolution of Software Development Practice

This table illustrates the growth in the software testing profession from the standpoint of size of the profession, methods for testing, and size of test teams. Over the course of a career, a professional must learn new technologies, adapt to process changes, and meet greater expectations about the level of practice. Kit's assessment of test methods and standards, and the level of organization independence, indicated significant change and growth in the profession over the past fifty years. Additionally, there has been an increase in the importance of the profession, the growth of the profession, and the complexity of the software products to be tested. Kit (1995, p. 9) stated,

Despite the enormous advances in the last 30 years, the software process (including the testing process) in most companies is still very immature. Furthermore, the complexity and criticality of the problems which software is expected to solve have become greater, and platform complexities have become

bigger, and this is tending to out-run our ability to put more effective methods, tools, and professionals in place.

Kit's views validate the importance of a skilled, trained professional quality assurance workforce. Yet, as he also pointed out, formal education is lagging behind the industry. This requires that software quality professionals be innovative in meeting their needs for continuing professional education.

The American Society for Quality has been a leading professional organization in establishing standards for the practice of software quality. The body of knowledge for the American Society of Quality's Certified Software Quality Engineer program encompasses validation and verification and many other topics of importance to the software quality assurance professional: development processes, standards, configuration management, project management, metrics, audits, and software quality management practices (American Society for Quality, 2007). Included in the body of knowledge are the core Total Quality Management philosophies of Juran, Deming, Ishikawa, and Taguchi as applied historically in the manufacturing industry (Schulmeyer & McManus, 1995). An understanding of such philosophies is critical to the development of software quality assurance practices as the industry evolves from ad hoc to sophisticated status. The use of statistical techniques is also essential to the continued improvement of software quality (Schulmeyer & McManus, 1999). In addition to this body of knowledge are the particular technical skills (software tools, programming languages, operating systems, networking protocols and hardware products) required for the execution of the required software quality tasking within the organizational paradigm.

Industry standards for software testing and quality assurance are important baselines for understanding the responsibilities and practices of the software quality profession. Standards include but are not limited to the following: IEEE (Institute of Electrical and Electronics Engineers), ISO 9000 (International Organization for Standards), SPICE (Software Process Improvement and Capability Determination), CMMI (Capability Maturity Model-Integrated) (Schulmeyer & McManus, 1999). The IEEE is a professional organization formed to support the electrical engineering profession and has a series of defined software quality processes and standards. ISO emphasizes the development of business process standards, including quality processes. SPICE is a working group of the International Organization for Standards with an emphasis on the software industry. The SPICE products include guides for use in assessing implemented software quality practices within an organization (Schulmeyer & McManus, 1999).

The CMMI best practices for conducting software quality assurance were developed by the Software Engineering Institute of Carnegie-Mellon University (Schulmeyer & McManus, 1995). CMMI is a valuable source of information for software quality professionals as they attempt to develop and implement improvements to corporate software development practices. These practices begin with ad hoc and move to more sophisticated quality management techniques. There is a cost in terms of time, learning and effort to implement the practices and gather appropriate data to support the higher levels of practice.

These organizations or affiliated consultants provide fee-based organizational learning/training programs to assist in adult learning and deployment of quality-related

business processes. Occasionally, such programs will be provided in the workplace; they are rarely offered at the university-level. A software quality professional becomes informed of the various standards through either workplace programs or self-directed learning to improve personal practice. The standards programs described above are helpful to the professional because they describe best practices for the industry. However, much of the continuing professional education offered for software quality assurance is solely process/practice related and overlooks the need for technical competency in the role. Software quality professionals are not guided by a professional organization in determining how to meet these ongoing needs. This creates an opportunity for self-directed and team-based learning.

Continuing Professional Education and Software Quality

Continuing professional education has a role in many professional fields such as accounting, the law, medicine, nursing, pharmaceuticals, teaching/education, project management, social work, and human resources (Grotelueschen, 1990). According to Cervero, "A central feature of North American societies in the twentieth century has been the professionalization of their workforces" (1990, p. 3). Cervero noted that nearly 25% of the American workforce is employed within a defined profession. The software quality profession has grown significantly since the 1960's and is an emerging profession. The professionalization of the workforce has been accompanied by a need for continued education beyond the degree program to stay abreast of developments in the professional fields with the intent of better serving the customer. This is true for the software quality profession as it moves to improved practices to meet evolving and increasing customer

requirements. The software industry was in its infancy in the 1960's (Kit 1995) and has

evolved rapidly through technological and process innovation. Continuing professional

education is needed to sustain and improve the practice of software quality professionals.

Continuing professional education is by no means a static domain. Cervero noted

four trends in the 1990's for continuing professional education (1990, p. 7):

TREND 1. *The amount of continuing education offered at the workplace dwarfs*

that offered by any other type of provider, and surpasses that of all other

providers combined.

TREND 2. *Universities and professional associations are active and important*

providers, with an increasing number of programs being offered in distance

education formats.

TREND 3. *There are an increasing number of collaborative arrangements among*

providers, especially between universities and workplaces.

TREND 4. *Continuing education is being used more frequently to regulate*

professionals' practice.

Workplace training, whether on-the-job, self-directed or instructor-led, is an

important part of skill development in the software development industry. Self-directed

learning is a form of workplace training (Bouchard, 1996). Adult learning initiatives in

the workplace are of paramount importance to the ongoing success of the business

endeavor and customer satisfaction (Blanchard, 2005). Some large corporations, such as

IBM, Apple and Motorola, have founded internal "universities" to provide technology

and process training and development to employees and suppliers (Motorola, IBM,

2008). It has been my experience that companies with fewer than 500 employees do not often invest in the development and delivery of such internal training programs and instead rely on self-directed learning.

With regard to the second trend, professional organizations have increased their focus on software quality assurance in recent years, with the emergence of two software quality certifications, regular conferences, and process-related course offerings. Some professional organizations are offshoots of established professional practice, as with the IEEE and ASQ. Others are newer entries specific to the software industry.

Collaboration between universities and industry, the third trend, has been evidenced through job retraining programs. An example is the 10-week software engineering retraining program provided to hardware engineers at Raytheon Corporation by the Software Engineering Research Center in the late 1990's (D.M. Zage, June 2008, personal communication). As our economy shifts toward information technology and knowledge, and away from the industrial and manufacturing era, re-training programs are important vehicles for transitioning workers. The Software Engineering Research Center is a collaboration between university graduate students and software organizations or businesses, emphasizing research programs that meet business needs. Some software companies hire summer interns from local universities; often the students join the companies after graduation. Universities serve as providers of workshops to software companies on specific topics, collaborators on research projects, and providers of new talent to the workplace.

The fourth trend indicates that continuing education is being used more frequently to regulate professionals' practice. Many professions require licensing or certification and

continuing professional education to conduct work within the profession. Examples include auctioneering, real estate, the legal profession, physical therapy, airplane maintenance and inspection, and food inspection. Some professions are emerging and not yet formally organized and certified for the protection of customers. The software quality profession is an emerging field that is not subject to mandated certification or continuing professional education requirements. Specialization requirements in the industry do promote the acquisition of vendor certifications, when available, for specific product technologies. Examples would include Microsoft, Oracle, SAP and Cisco certifications. Local Raytheon and Lilly employees are now required to hold the CSQE certification in their role as software quality professionals in Indianapolis. There is increasing employer consideration of qualifications for performance of this role.

There are other ways to view continuing professional education in software quality aside from the trends noted by Cervero. Nowlen (1988, p. 31) identified several models for evaluating continuing professional education including the Competence Model, the Update Model, and the Performance Model. These models are helpful to the consideration of how diverse learning needs are met within the software quality community. "Competence is most generally defined as marked or sufficient aptitude, skill, strength, judgment, or knowledge without noticeable weakness or demerit" (Nowlen, 1988, p. 31). The Competence Model is driven from job function analysis as the hub. In this model one seeks to identify "What competencies are at work in successful professional performance?" (Nowlen, 1988, p. 31). According to Nowlen (1988, p. 59), competencies can include motivation, subject area knowledge and skill, traits such as initiative and critical thinking ability, values, and attitudes. This view is employer-

centered and is evidenced in the formal job descriptions for software quality positions. Conversely, this view can be used as a self-appraisal tool to define self-directed learning goals, such as identifying shortcomings in comparison to defined job requirements.
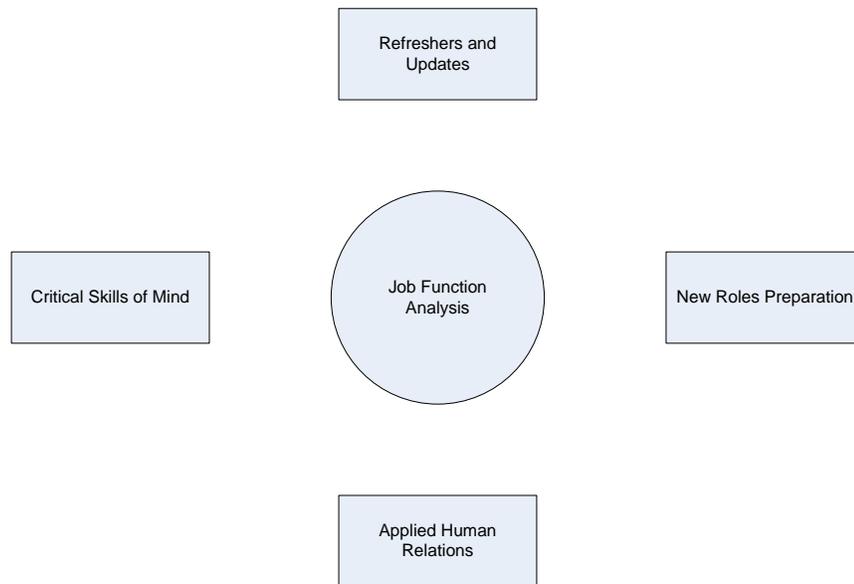
Figure 1: The Competence Model (Nowlen, 1988, p. 32)

Figure 1, above, shows the relationship of learning opportunities to the job function analysis.

The Update Model, Figure 2, suggests a more learner-centered approach to defining continuing professional education needs, with an emphasis on the need to keep up within the profession. This model has commonalities with the software quality professional organizational approach to meeting learner-defined needs. Six-Sigma training classes offered by ASQ are an example of a professional organization addressing the learning needs for new skills within the industry. Companies such as Motorola and Xerox have also taken the lead in providing this type of learning within the workplace.

As noted by Cervero (2000), workplaces are dominant providers of professional training.

The Update Model includes informational updates through two to three daylong short

courses including professional knowledge updates and technology transfers. Nowlen does

not view the Update Model of CPE as providing lasting improvement to professional

performance. From the standpoint of "keeping up", it is valuable to consider the practice

of self-directed learning within the Update Model and how it might be used in the

workplace as an important learning strategy. The benefit of the Update Model is its focus

on the learner and the need to maintain professional practice or competence.

New Knowledge/
Skills

A Profession's
Knowledge/Skill Base

Keeping Up

New Technology

Applied Human
Relations
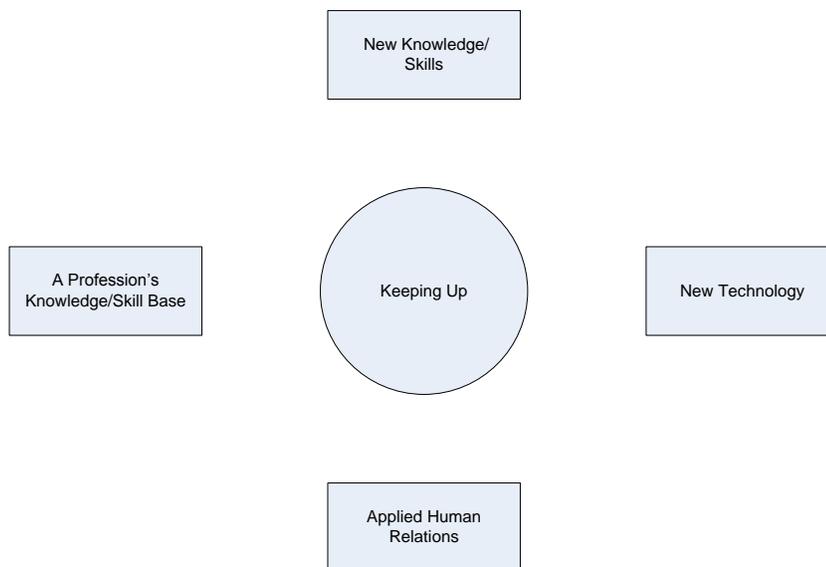
Figure 2: The Update Model (Nowlen, 1988, p. 24)

> Houle takes a stronger position on the value of the underpinnings of this model.
>
> Many people are growing irritated by what seems to them to be a mindless
>
> proliferation of courses and conferences, each of which may be valuable but
>
> which are not collectively undergirded by any unifying conception of how

education can be used in a mature, complex and continuing way to achieve excellence of service throughout the lifespan. (Houle, 1980, p. x)

This indicates a mismatch between the professional organization learning offerings and the learner needs as viewed through the lens of a professional's career.

Nowlen's Performance Model, Figure 3, is driven from an employee-centered perspective where individual performance is reviewed in the context of his model elements. The employee self-identifies factors contributing to performance issues and learning agendas are developed in response to the analysis of the issues.
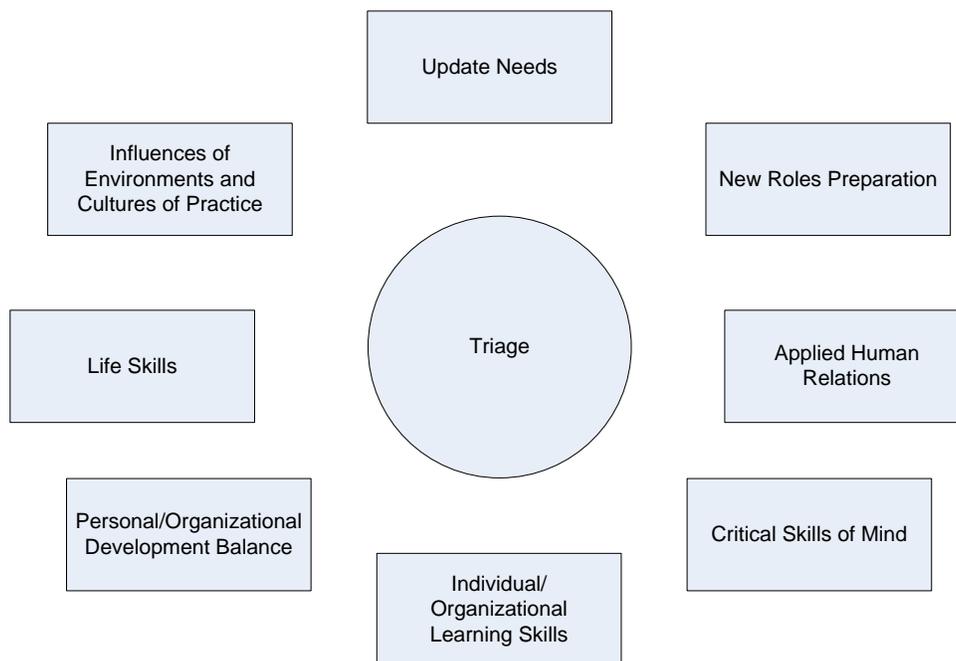
Figure 3: The Performance Model (Nowlen, 1988, p. 87)

The Performance Model incorporates the professional's views on their individual skills and needs in addition to consideration of the impact of the organization. As noted by Nowlen, and appropriate for the assessment of a software quality professional:

The focus for the triage brings more than job functions into view. The focus also

includes any other variables that are demonstrated to have a strong influence on

performance: baseline knowledge and skills; the challenge of new roles; requisite

skills in human relations; critical skills of mind; proficiency in self-managed

learning; individual development progress, organizational developmental balance,

and the fit of individual and organization to one another; skills in coping with

life's surprises as well as its anticipatable transitions; and understanding of the

influences of environments and cultures and the skills to orchestrate them.

(Nowlen, 1988, p. 86-87)

The Performance Model is useful in understanding how a software quality

professional might identify and pursue self-directed learning objectives for continuing

professional education. This model provides a scope of adult CPE that is much broader

than the Update Model with the inclusion of additional elements that impact professional

development, such as critical thinking or human relations skills.

The Performance Model also emphasizes the learner's subjective interpretation of

areas for self-improvement. According to Houle, "the effort to achieve excellence must

be based on the realization that it is ultimately subjective. Procedures can be refined,

outcomes can be measured, authorities can be cited, precedents can be followed, and data

can be brought to bear upon decision-making processes, but qualitative conclusions must

always be judgmental" (1980, p. 269). Rather than rely on workplace or professional

organization dictates of skill and knowledge competency, the software quality

professional following the Performance Model of continuing professional education

would be customizing a self-directed learning program and revising it over time.

Continuing professional education is not mandated within the software development industry at this time, in comparison to other professions such as social work, education, and engineering. It is conceivable that such requirements may develop in the future. According to Arnold and Scaramella,

> During the past 25 years, there has been a growing concern among consumer groups, various governmental agencies, and professional regulatory boards with respect to the competency of practitioners in several professions and occupations. Dramatic advances in technology and the "information explosion" our society has been experiencing have caused many to question whether initial professional licensure or certification ensures competency throughout the span of an individual's career. (1998, p. 268)

There is no regulatory oversight of the software development industry and there are no requirements for demonstration of competency within the profession. Arnold and Scaramella (1998) referred to the impact of technological change on professional careers. Software quality professionals are heavily impacted by the advances in technology. As with any profession, it is beneficial for the software quality professional to engage in lifelong learning to maintain effectiveness (Billington, 1988; Schulmeyer & McManus, 1995). The contribution of self-directed learning to CPE for software quality is unknown due to the lack of prior research on this adult learning community. However, Nowlen's models for CPE provide a framework for identifying how self-directed learning activities of a software quality organization would map to workplace and individual needs. Additionally, Houle's views on learner-centered CPE lead to the question 'who identifies software quality professionals learning needs'. User- or learner-centered learning

activities are preferable to those mandated by management or organization for several

reasons. Learners are in the best position to undertake critical self-reflection to identify

learning objectives and complement these objectives with learning programs that suit

their preferences and styles. Intrinsic motivations to undertake new learning are more

successful in reaching objectives than extrinsic motivations (Senge, 1999).

Self-Directed Learning and Continuing Professional Education

Knox builds upon Houle's (1980) premise that more than half of continuing

learning in the professions is self-directed by suggesting that "professional education

programs should build on, encourage, and complement self-directed learning" (Knox,

1990, p. 15). This perspective is important to this study because it is learner-centered

rather than provider-centered. Lowry (1989) indicated in her article "What is self-directed

learning?" that approximately 70 percent of adult learning is through self-directed

activities. This implies that self-directed learning may be at the heart of continuing

professional education in the software quality profession. I have found no research

studies that have focused on adult learning in the software quality profession,

substantiating the need for research in this area. Cervero (2000) conducted research in

continuing professional education for professions requiring licensing or certification and

indicated that such education is mandated as a means to regulate practice. He referenced

the professions of public accountants, lawyers and pharmacists in his review of

professions impacted by growing state requirements for continuing education. Ottoson

(2000) stressed the importance of knowing whose needs are being met by CPE – the

practitioner or the consumer. State-mandated continuing education programs are

grounded in the protection of the consumer; self-directed learner-defined continuing education is grounded in meeting the professional needs of the practitioner.

Knowles provided a broad description of self-directed learning, as follows, which gives a context for understanding both the process and the terminology familiar to the learner:

> In its broadest meaning, "self-directed learning" describes a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes. Other labels found in the literature to describe this process are "self-planned learning," "inquiry method," "independent learning," "self-education," "self-instruction," "self-teaching," "self-study," and "autonomous learning." The trouble with most of these labels is that they seem to imply learning in isolation, whereas self-directed learning usually takes place in association with various kinds of helpers, such as teachers, tutors, mentors, resource people, and peers. There is a lot of mutuality among a group of self-directed learners. (Knowles, 1975, p. 18)

This definition describes the process that self-directed learners use to improve practice and recognizes the important role of a support system for the learning process. It was important to this study to consider the various ways in which software quality professionals refer to what adult educators call "self-directed learning". Reflecting on Knowles' remarks about mutuality, this research activity also inquired about the role of support systems for self-directed learning within the software quality profession.

Lowry (1989) indicated that many adults who pursue self-directed learning are attempting to improve their work performance through new skills, knowledge and attitudes. Yet some employees are incapable of engaging in self-directed learning for a number of reasons including lack of confidence or resources. As did Knowles, Lowry (1989) identified a number of roles for educators and institutions to facilitate self-directed learning. These roles include being a manager of the learning experience, provider of context for the learning activity, teacher of inquiry skills, advocate for underserved populations, planner for objective setting, developer of instructional materials, promoter of learning networks and study circles, and leader in the establishment of ethical behavior and trust. Although these roles were defined for educators and institutions, they are applicable to those who manage software quality professionals. The study of software quality professionals' self-directed learning within an organization should identify if, or how, managers fulfill these roles in facilitating or supporting self-directed learning. This perspective may seem to be in conflict with the need for self-directed learning to be learner-centered however these "roles" reflect the mutuality cited by Knowles.

Workplace Culture

Lowry's (1989) and Knowles' (1975) comments reinforce the role of leadership and the importance of organizational values in sustaining a workplace that encourages, supports, recognizes and rewards self-directed learning. Daley (2002) similarly identified culture as an important characteristic of the context for adult learning in the form of continuing professional education. She discussed four characteristics that influence the professional's use of new information: (1) allegiance to the profession, (2) nature of

professional work, (3) variations in organizational culture, and (4) level of independence and autonomy. Daley says "…it is often the involvement in and nature of the actual work in which professionals engage that drive what they learn" (2002, p. 83). Within software quality, professionals have learning requirements related to the unique circumstances of their role in terms of process and technology. Daley's research provides a context for understanding the role of independence and autonomy, as provided within an organizational culture, in defining self-directed learning objectives. Through a study of a software quality organization's use of self-directed learning, I assessed how independence, autonomy and culture are components of a support system.

Team-Based Learning

There are occasions when teams or groups engage in learning experiences in the workplace. Buffington (1998) engaged in action research to identify ways to improve the learning experiences of self-directed teams. His emphasis on a team orientation to learning is due to his research that supports collaborative learning as a means to "more efficient and effective processing and retention of information" (Buffington, 1988, p. 76). Buffington defined the instructor as critical to the establishment of objectives but places the team at the center of the learning experience. He believed that businesses have an expectation that professionals entering the workplace will have had successful team learning experiences in the higher education environment. His research takes us one step further with self-directed learning to emphasize the need for adult professionals to be able to engage in team learning activities. I built on his research by studying how self-directed team learning is deployed in a software quality organization. The target organization uses

the agile software development method, in which the team is self-directed. In lieu of an instructor or facilitator, how do such self-directed teams identify learning objectives?

Another factor that influences the individual or team undertaking learning activities is the power relationship between manager and employee(s), as described by Owenby (2002). Owenby asserted that learning organizations are "effective to the extent that they are horizontal in nature" (2002, p. 52), and that the design of a learning organization should take into account the power relations of the workplace if they are to succeed. His views on horizontal learning organizations advocate project-based learning teams as the means to form and develop learning networks within companies. Owenby (2002) also described how issues of class, race, and sex in the workplace influence participation and learning ("the dark side"). His conclusion is that "Organizations that are thoroughly committed to transformational learning must provide the widest possible training in critical reflection and action inquiry to ensure the widest possible transformational consciousness among their members" (Owenby, 2002, p.58-59). In light of these views, the study of self-directed and team learning within a software quality organization brings to light some of the political elements that create barriers to or enable team or self-directed learning and are reflective of the support systems.

Project teams are often subject to organizational change initiatives, according to Senge (1999). Such change initiatives can be political in their design and deployment. He identified key qualities associated with important organizational change initiatives that are successful. These qualities are aligned with a culture that enables self-directed learning:

- They are connected with real work goals and processes;

- They are connected with improving performance;

- They involve people who have the power to take action regarding these goals;

- They seek to balance action and reflection, connecting inquiry and experimentation;

- They afford people an increased amount of "white space": opportunities for people to think and reflect without pressure to make decisions;

- They are intended to increase people's capacity, individually and collectively; and

- They focus on learning about learning, in settings that matter. (Senge, 1999, p. 43)

Senge proposed that initiatives driven by learning be sustainable by an organization and not dependent upon "a single leader's continued effort to feed the system with enthusiasm, ideas, and initiative" (1999, p. 41). Senge is a proponent of a culture of organizational and self-directed learning. His research has reinforced the importance of opportunity, resources, and a user-centered learning program. It should be noted that Senge's model of the learning organization is an ideal and it is rare for a single organization to reflect all of the characteristics he identified. In some technology organizations, the learning initiatives are driven externally through advancements, whether a new server operating system platform or a new release of a programming language. The move to agile software development from the more historical waterfall development process has pressed individuals and organizations to adapt to the changes in practice. The waterfall software development process has been practiced for decades and

is based on clearly defined entrance and exit criteria for each phase. The agile process is much less rigorous in the definition of roles and criteria within the process, requiring cultural adaptations within an organization. Agile development is not well suited to mission critical software applications due to the more ad hoc and unmeasured nature of the process. Senge's beliefs on organizational and self-directed learning, described above, are applicable to the software quality profession as it embraces shifts in process and workplace culture. His research, however, has been with core business organizational functions and not specialty professions such as software quality.

Authorship

Bolman and Deal (2000), like Senge, emphasized the importance of authorship in the empowerment of employees. They suggested that the leader's role is to define the journey and provide opportunities and an environment that supports individual and team achievement. Self-directed learning and authorship can co-exist in an environment that defines the journey and rewards growth. Bolman and Deal (2000) also suggested that a sense of significance is critical to the health of the employee and workplace culture. A review of software quality professionals' annual appraisals provided a view as to the origins of learning objectives – whether they are driven by management or self-identified by the professional.

Schön described knowing-in-action, a form of professional artistry that refers to the "kinds of competence practitioners sometimes display in unique, uncertain, and conflicted situations of practice" (1987, p. 22). A knowing-in-action style reflects a form of self-directed learning driven from recognition, judgment and skillful performance. In

essence, the learner continuously, and often unconsciously, creates new knowledge in daily activities. Reflection-in-action, as described by Schön (1987), is when the learner consciously reviews his thoughts and actions to determine how to improve outcomes. It is when an employee engages in reflection-in-action that provides the opportunity to identify learning needs. Nowlen's Performance Model (1988) provides a context for such an evaluation for continuing professional education needs.

Bouchard (1996) researched the question "What makes self-directed learning happen?" Bouchard conducted an ethnographic, qualitative study to better understand not only how adults engage in self-directed learning, but also how they begin to teach themselves in the process. Bouchard proposed three sets of explanations for the existence of self-directed learning: the individual's self-instructional proficiency, personality characteristics, and fortuitous occurrences in the environment. He determined that self-directed learners possess an emergent goal structure comprised of a set of professional objectives, unusual learning strategies considered diverse and creative, and an autodidactic leap where, often under pressure, the adult learner accepts responsibility for achievement that requires a significant leap in skill or ability. Some of the personality traits of self-directed learners cited by Bouchard include creativity, optimism, a high capacity for learning, curiosity, and a strong belief in their ability to learn autonomously. Bouchard found that transformational learning was often at the heart of self-directed learning activities and most of the learners did not feel well suited to formal education. Some of Bouchard's informants were professionals working in the field of computer science, so there is relevance to this research study of the continuing professional education habits of software quality professionals.

Some researchers focused specifically on the learning needs in the knowledge industry. Billington stated,

> With our ever-accelerating speed of change in both knowledge and technology, it is clear that we adults have a choice: We either continue to learn throughout our lives, or we allow our skills and knowledge to quickly slide into obsolescence. This same principle applies to companies: Those who fail to continually teach and train employees quickly slide into obsolescence. (1988, p. 1)

Billington studied the factors of adult learning environments that best facilitate growth and development. One of the factors she stresses in her study is the need for adults to take responsibility for their own learning through self-directed learning. She also stressed the need for an environment that "fosters intellectual freedom and encourages experimentation and creativity" (Billington, 1988, p. 2). Billington's (1988) research reinforces the perception that being self-directed is critical to professional continuing education in the knowledge and technology fields.

Another researcher who focused on technology and learning, Flagello (1998) more clearly stated the role of lifelong learning in the professions and the centrality of the learner:

> The metagoal of all of the recent emphasis on changes within the workplace seems to be the desire to plant the seed that a new era has begun in America and the professional workforce had better wake up to it and take action. Change is the only constant and in order to change, each person will have to take more responsibility for keeping pace with technology and what that technology is doing within the workplace. Ongoing education, or more precisely continuous learning,

both on a formal and an informal level, will be the requirement for all employees

to remain competent about an ever-expanding body of knowledge and be key

players on the playing field of life. (Flagello, 1998, p. 43)

The emphasis on the responsibility of the individual in the learning process cannot

be understated. Flagello (1998, p. 45) insisted that through empowerment individuals

chart their own journeys of continuous learning.

Empowerment frees the professional to choose, collaborate, and commit. It is

about ownership, responsibility, and outcomes that are congruent with personal

choices. …In many ways empowerment requires the professional person to

abdicate an implied company security for one that is self-created, one with

intention and purpose stemming from the professional endeavor and linked to it

by virtue of the commitment the professional makes to his or her profession, not

some perceived corporate caretaker. This cannot be forced or faked.

Flagello accurately described today's ideal employee in the software development

industry. Employee empowerment, the authorship described by Bolman and Deal (2000),

nurtures the individual confidence needed to sustain self-directed and team-based

learning within an organization.

More recently, Wonacott (2002, p. 3) provided evidence of a new kind of

knowledge worker – the gold-collar worker – "whose most valuable assets are problem-

solving abilities, creativity, talent, and intelligence; who performs nonrepetitive and

complex work that is difficult to evaluate; and who prefers self-management." Wonacott

(2002, p. 3) advocated a hands-off approach to managing gold-collar workers "by setting

goals rather than controlling processes involved". Workplace flexibility is encouraged to

provide non-financial rewards and benefits such as casual dress, part- or full-time

telecommuting, flextime, and challenging assignments. "To sum up…the multi-skilled,

knowledge-based, gold-collar worker, using information to solve problems and create

solutions, is highly valued and likely to become even more so. Employers and educators

need new ways to manage, recruit, retain, and educate them" (Wonacott, 2002, p. 4). One

of the ways that this can be achieved is through the establishment of a culture and

resources to support self-directed and team-based learning activities.

Although the terminology for the concept of personal autonomy for self-directed

learning varies from one researcher to another in this field, there is a common thread of

the critical importance of learner-defined continuing professional education. In the

complex field of software engineering, with its fast pace of change, organizational culture

influences whether such an approach is supported and viable.

Political Aspects

Brookfield (1993) saw access to resources for self-directed learning as a political

enabler or barrier to the adult learner. This political perspective of culture is similar to

Owenby's discussion of the "dark side". Brookfield also identified the individual's

cognizance of his need to learn (self-reflection) as a critical aspect to the success of a

learning endeavor. His views reinforce the importance of organizational culture in

promoting self-directed learning, and support the need for the study of self-directed

learning in the software quality profession. The enablers or barriers to such adult learners

were discussed in this study's focus group sessions and described in Chapter 4.

Several aspects of continuing professional education are clear. User-defined learning objectives are key to successful adult education outcomes. Self-directed learning is the most common method of learning for the majority of adults. Team-based learning enhances understanding and retention. Professionals that are empowered within the workplace culture are more likely to engage in continuing education. Finally, the 'gold collar' worker is one who engages in ongoing continuing professional education and applies new knowledge in the workplace.

Status of Software Quality Continuing Professional Education

Several formal continuing professional learning opportunities exist for the development of software quality assurance skills and knowledge, mainly process-focused. Offerings include Air Force Institute of Technology training, community college courses on software testing, and IEEE and ASQ training in software quality engineering. The Indianapolis Quality Assurance Association (IQAA) recently offered a one-day workshop by Randy Rice on *Becoming an Influential Test Team Leader.* This type of workshop is an attribute of Nowlen's Update Model of continuing professional education. Beyond process proficiency, the software quality professional must develop a broader set of personal proficiencies including technical competency, critical thinking, project management, interpersonal and team communication, customer and project research, negotiation, self-advocacy, entrepreneurial perspectives, presentation, process improvement, listening, and other social and business skills. Many of these skills are defined in the ASQ Certified Software Quality Engineer body of knowledge (ASQ, 2007); however, training programs fall short in delivering on all of these elements.

In addition to teacher-directed workshops and classes, software quality professionals can undertake self-directed learning in many ways, thanks to the Internet and the associated ability for such services to be delivered. Journals are an accessible source of information on software quality practices and research; an example includes the November 2007 version of *Software Test and Performance,* which can be retrieved from http://www.stpmag.com/. It includes articles about metrics, best practices, and test tool reviews. The American Society for Quality *Software Quality Professional* journal can be retrieved from http://www.asq.org/pub/sqp/. The ASQ journal is more research-oriented in its publication of articles than *Software Test and Performance.* Both journals contribute to software quality professional knowledge. The American Society for Quality also offers local/regional sections, which provide monthly meetings and occasional workshops, including the Certified Software Quality Engineer refresher. Some ASQ sections within the country, such as Austin, Texas, are more active in dialogue and training regarding software quality management than others, such as the Indianapolis, Indiana section which focuses mainly on manufacturing and the pharmaceutical industry.

The American Society for Quality offers the Certified Software Quality Engineer (CSQE) through examination. The potential CSQE must possess a minimum of eight years of experience and knowledge of core practices including quality philosophies and methods, software metrics development, project and configuration management, and software inspection, testing, verification and validation (ASQ, 2007). Reading materials are available to the learner for self-study and exam preparation classes are held periodically. The ASQ also offers webinars on software processes including CMMI, Six Sigma, and use case techniques. Webinars are a means of obtaining self-directed learning

in the profession. They are pre-recorded or live sessions delivered over the Internet via digital streaming with audio. They sometimes have an interactive chat function available to ask and answer questions.

Microsoft provides an online forum, Tester Center, for software test self-directed learning (Microsoft Tester Center, 2007). The site claims "The Microsoft Tester Center showcases the test discipline as an integral part of the application lifecycle, describes test roles and responsibilities, and promotes the test investments required to deliver high-quality software (Microsoft Tester Center, 2007, p. 1). The software quality professional can engage in a learning forum with other professionals, a "Patterns and Practices" section providing software quality process documentation, and a "Tester Column" that enables professionals to ask questions and receive feedback on issues like software security from a Microsoft professional. The IEEE emphasizes software engineering continuing education and offers online training such as Planning and Performing Failure Mode and Effects Analysis on Software by Nathaniel Ozarin (IEEE website, 2007).

Summary

The software quality profession lacks a formal continuing professional education program. Adult learning objectives are established within the workplace, either by management or the employee. Current CPE activities external to the workplace emphasize the software quality assurance processes over technology learning, indicating a shortfall in opportunities for software quality professionals to meet the requirements of their role. The gap in software quality assurance professional learning exists between role/process and technology/competency. A software quality professional can obtain

continuing professional education related to the practice of the profession but must be

more self-serving in identifying opportunities to meet technology-learning objectives.

This is where self-directed and team-based learning become critical vehicles for

professional education and improvement of practice.

Chapter Three: Research Methodology

Introduction

  This study is a qualitative, exploratory case study of a single software quality assurance organization. According to Yin, an exploratory case study is appropriate for situations where "the intervention being evaluated has no clear, single set of outcomes" (2003, p. 15). The "interventions" under evaluation are self-directed and team-based learning as means of obtaining continuing professional education. I explored the way in which self-directed and team-based learning are used, within the software quality organization that I lead, to meet continuing professional education needs. I also sought to understand who established learning objectives. Yin stated that, "A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (2003, p. 13). It is not clear how software quality professionals obtain continuing professional education in the context of their work and profession.

  I sought information about the software quality professionals' self-directed and team-based learning habits related to the profession, both on the job and personal learning. There is no prescribed certification or licensing model for such professionals nor are there any requirements for continuing professional education in this field, as one might see in other professions such as nursing, the law, and accounting (Kit, 1995). It is

currently left to the organization (management) or the individual to define appropriate continuing professional learning within the context of the work to be performed.

Because self-directed learning is undertaken by a large percentage of adult learners, I wanted to know how software quality professionals used this method to solve problems and expand their skills and knowledge. The focus of team-based learning, and whether it was onsite or offsite, was also sought. I wanted to understand the various forms of self-directed and team-based learning that occur in this organization.

Purpose of the Study

This study sought to understand how self-directed and team-based learning is used to meet continuing professional education needs in the software quality field. The study contributes to the baseline of literature regarding self-directed learning as a means of achieving continuing professional education objectives. A lack of research in the software quality profession regarding continuing professional education models, combined with the cultural pressure for high levels of software quality, provides the rationale for this study. The study examined self-directed and team-based learning in the software quality profession within the context of contemporary theories related to continuing professional education. It also sought to improve the understanding of how emerging and unregulated professions meet ongoing learning needs.

Merriam and Caffarella (1999) believed that "there continues to be a vast array of studies on self-directed learning…that development of a richer research agenda in self-directed learning has been slow to evolve. We attribute this lack of new direction to three causes: insufficient critical dialogue and use of the theory and models that have been

developed, continual disregard of the observations of previous researchers about

recommendations for future research, and predominant use of the quantitative or

positivist paradigm in data-based studies" (p. 311). A single case study of the self-

directed and team-based learning behaviors of a software quality organization in the

context of continuing professional education provides the opportunity to contribute to the

current base of research. A lack of clear continuing professional educational strategies for

the software quality professionals begs the question of how they meet ongoing

technology and process changes in the industry.

Theoretical Perspective

My theoretical perspective is progressive with a focus on improving the

knowledge base regarding self-directed and team-based learning in the software quality

profession. My progressive perspective allows me to view adult learning with the

objective to identify supporting behaviors and barriers or enablers to professional skill

development and application. According to Galbraith, progressive adult education has a

purpose "To promote societal well-being; enhance individual effectiveness in society; to

give learners practical knowledge and problem-solving skills" (2004, p. 73).

Zinn (2004) described the progressive philosophy as having its roots in John

Dewey's adult education philosophies, emphasizing the learner in determining objectives

and stressing a problem solving approach. The progressive philosophy is an appropriate

perspective within which to view self-directed and team-based learning in the software

quality profession in its evolution as an emerging profession. Self-directed learning is a

vehicle for engaging in hands-on activities, congruent with Dewey's (1944) theories on

experiential learning, leading to better retention of knowledge. Team-based learning is thought to increase participant learning and comprehension. This research provides insight into the way in which self-directed and team-based learning is user-defined and how it is sustained within a software quality organization.

I sought to understand the way in which software quality professionals in this organization met their continuing professional education needs for workplace competence through self-directed and team-based learning activities. Inclusion of the adult learners' experience is also an important element of the progressive philosophy therefore I interviewed the focus groups on their self-directed and team-based learning activities and objectives.

Research Concepts Applied to this Study

This case study activity is based on a qualitative research approach. The following sections describe qualitative research, case studies, and several other techniques that were used in this study.

Qualitative research.

According to Wiersma,

Qualitative and quantitative research represent two distinctly different approaches to understanding the world, that is, the phenomena being researched. Qualitative research has its origins in descriptive analysis, and is essentially an inductive process, reasoning from the specific situation to a general conclusion. Quantitative research, on the other hand, is more closely associated with deduction, reasoning from general principles to specific situations. (2005, p. 13)

This research activity is qualitative and context-specific with a focus on the software quality assurance engineers that are members of the quality organization that I lead. Qualitative research involves the physical and cultural aspects of the organization under study, and such elements have been considered in this research activity. Both facts and values (Wiersma, 2005) are gathered in the course of the research and the representation of this information is holistic. If theories emerged from the data that were collected then it is considered to be grounded theory, or theory that is generated from the data and not from pre-existing theories. Wellington (2000, p. 18) confirms this qualitative approach by identifying grounded theory as a guiding principle, in addition to emphasis on descriptive research, values, and inductive reasoning. Wellington described qualitative research as providing "richness and colour" (2000, p. 18) with the researcher as the key instrument for data collection, situated within the world under study.

Practitioner/insider research.

Wellington (2000) described some of the possible advantages and problems of qualitative research where the researcher is a practitioner or insider within the group under study. He noted that, "improved insight into the situation and people involved" through insider knowledge as one potential advantage as well as "better personal relationships" with the participants (2000, p. 20). Wellington indicated that some researchers who are insiders may not be as open-minded as an external researcher, may have a status in the organization that causes issues, and may have preconceptions that influence the research.

Case study.

Wellington (2000) described several types of case studies that can be conducted as forms of educational research. The instrumental case study is described as an approach 'used to provide insight into a particular issue or to clarify a hypothesis' (2000, p. 93). Other forms of case study research include the intrinsic case study and the collective case study (multiple cases). Wellington noted that a case study might include a review of resources within an organization. He cited equipment, room design, and management of human resources as examples of potential resource elements to be studied as features of the case study. Wellington stated that, "Impression and intuition, interviewing and observation, and the study of documentation all form part of the 'case record' (2000, p. 94). Some of the strengths of the case study approach, according to Wellington, include being illustrative, attention-holding, and of value in teaching (2000, p. 97). Alternatively, case studies may not be generalizable, representative or typical, or repeatable (Wellington, 2000, p. 97). These types of strengths and weaknesses should be considered in the use of the case study research approach.

The case study method, according to Merriam (1998), has three essential properties:

1. Particularistic. Case studies focus on a particular situation, event, program, or phenomenon.

2. Descriptive. The end product of a case study is a rich description of the phenomenon under study.

3. Heuristic. Case studies illuminate the reader's understanding of the
   phenomenon under study. They can bring about the discovery of new
   meaning, extend the reader's experience, or confirm what is known. (p. 29-31)

Focus groups.

Vaughn (1996) indicated that focus groups are distinguished from other forms of
qualitative interview approaches by their emphasis on group discussion. "The major
assumption of focus groups is that with a permissive atmosphere that fosters a range of
opinions, a more complete and revealing understanding of the issues will be obtained"
(Vaughn, 1996, p. 4). The goal of focus group interviews is to achieve a dialogue on the
topic under study. Vaughn provided a summary of core elements of focus groups:

- The group is an informal assembly of target persons whose points of view
  are requested to address a selected topic.

- The group is small, 6 to 12 members, and is relatively homogeneous.

- A trained moderator with prepared questions and probes sets the stage and
  induces participants' responses.

- The goal is to elicit perceptions, feelings, attitudes, and ideas of
  participants about a selected topic.

- Focus groups do not generate quantitative information that can be
  projected to a larger population (1996, p. 5).

Focus groups are more formal that other types of small group discussion with
structured or semi-structured interview questions and an intention to analyze the
transcripts from the sessions to determine findings. According to Vaughn (1996), focus

groups do not aim to gain consensus or solve problems; rather, focus groups attempt to

gain individual points of view and opinions. Vaughn stated that, "Focus groups are best

used when conducting exploratory research" (1996, p. 6). Some of the benefits of the

focus group interview include compatibility with qualitative research through

examination of the nature of reality expressed by participants, opportunities for direct

contact with subjects, and the dynamic aspects of discussion within a group (Vaughn,

1996). Vaughn believed that the focus group format, in contrast to individual interviews,

enabled participants to 'loosen up' and feel comfortable being direct in their

participation. Additionally, Vaughn stressed that research questions for focus group

interviews are "those related to exploratory or explanatory issues" (1996, p. 23).

Documentary information.

Yin (2003) stressed that an element of the case study approach is seeking

documentation to support the study. The data collection plan for a case study should

identify relevant documents that provide insight into the research questions. Yin stated

that, "the most important use of documents is to corroborate and augment evidence from

other sources" (2003, p. 87). Two of the strengths of documentary information, as noted

by Yin, include exactness and unobtrusiveness. Two of the weaknesses cited by Yin were

the possibility of introducing bias through incomplete collection and challenges in

retrievability. Examples of documentary information include letters, memos, reports, and

files.

Methods Applied to This Study

This research is a single, exploratory case study of a software quality organization that I lead in central Indiana. As the researcher, I also held the position of insider to the organization. The case study is particularistic in that the study sought to understand the role of self-directed and team-based learning within an emerging profession. The study provides a rich description of the application of self-directed and team learning as well as enablers and barriers to such learning. Additionally, the study illuminates the way in which self-directed learning and team-based learning are used to meet the needs of continuing professional education within the organization.

Merriam and Simpson (1995, p. 18) discussed the importance of "Setting Up The Problem". They encouraged the researcher to consider the question of why one should care about the research activity. Our culture is becoming increasingly reliant on software products to conduct daily life and business. The pace of technological change is very rapid. Therefore, it is a challenge to guide the software quality professional in continuing education to assure the quality of increasingly complex and interoperating software products. This research study is a small step in understanding the self-directed and team-based learning culture of software quality professionals from which other important research studies may be spawned, with the hope of providing improved learning opportunities within the profession.

My research questions are:

- How is self-directed learning used in this software quality assurance organization to meet continuing professional education needs?

- What is the role of team-based learning to meet continuing professional education needs?

- What barriers or enablers to continuing professional education exist in this organization?

- Who establishes the learning objectives for continuing professional education? Are the objectives learner-centered and learner-defined?

- How are continuing professional educational theories reflected in the participant feedback on learning objectives?

  Some of the assumptions (Yin, 2003) underlying this research include:

1. Self-directed learning is an important method of valid continuing professional education for the software quality profession.

2. Self-directed learning by teams enhances individual efforts to improve professional competence.

3. Cultural support systems and resources are important to the achievement of such self-directed learning activities.

Semi-structured interview questions were used as a guide to facilitate the discussion within the focus groups that were comprised of software quality professionals. Interview questions were reviewed by two experts in the field of adult education for software engineering. These experts are professors of software engineering and are familiar with the role of software quality and the terminology used in the industry. They provided feedback on comprehension and appropriateness of the questions prior to any interview sessions. The focus groups, which lasted approximately one and a half hours each, were digitally recorded and transcribed. Transcripts were shared with one leader

from each focus group for review and verification of accuracy. They had the opportunity to modify the transcripts for accuracy. The transcripts were distributed as attachments to email messages. The feedback included only instances where I had used a proper name, and those instances were modified to provide anonymity.

An additional means of verifying feedback occurred through a review of 2008 employee-development objectives (documentary information) as established by the software quality professional and their project manager. The target organization operates as a matrix engineering organization and the professionals' performance is reviewed annually by project managers, rather than by functional management. This provided greater objectivity in understanding the origin of learning objectives (individual or manager), as the professionals take their direction from project managers. The learning objectives were provided by participants who copied and pasted them from their annual review files (from a commercial software application) into email messages sent directly to me. I compiled the goals into a summary table (Table 3, Chapter 4). The annual review format has a section for employee-identified objectives and another section for management-identified objectives.

Population

The study focused on the software quality organization that I lead at a central Indiana software company. The organization is diverse and comprised of approximately forty employees. Both men and women are represented in the population, as are people from different cultures (including Romania, Indonesia, and Nigeria). The thirty focus group participants included software quality team leads, software quality engineers,

configuration management and test automation engineers, and software quality architects. Each of these roles is performed in a typical software quality organization. There are approximately a dozen team leads (a.k.a. leaders); each supervises several software quality professionals working on a specified software product. Software quality engineers are individual contributors who specialize in one or more areas of process and/or technology. Most of the teams have a designated team lead that provides tasking, support, and performance feedback to participants. These leads provide schedule input and resource requirements to the project managers, in addition to status reporting with respect to risks associated with product quality. Configuration managers specialize in the tools and processes needed to control, change, build, and release software versions within an organization. Test automation engineers dedicate their time to scripting manual test activities for regression test purposes or develop framework code to support test scripting. Finally, software quality architects focus on auditing project quality status, researching new product releases, performing specialized software research, and coaching or supporting other software quality professionals in the organization.

Focus groups were facilitated through semi-structured interview questions. The size of the organization required that the interviews be consolidated into four focus groups of six to ten participants. Grouping of participants were based on their project team assignments. A total of thirty people participated in the focus groups. Employees were sent email invitations to participate in a focus group session; if there was a schedule conflict, the employee was offered an opportunity to participate in a subsequent session. Ten employees were unable to participate due to scheduling conflicts. Participation was strictly voluntary and informed consent was obtained prior to each focus group session.

Employees who were excluded from participation included the technical writer and the technical course developer.

Data Collection

There are several levels of questions in a case study design (Yin, 2003). The first-level of questions involves those asked of interviewees. Semi-structured interviews provided the opportunity to ask probing questions to gain more depth of response to the interview questions. The second-level of questions are those that the principal investigator would like to answer through the case study. The third-level of questions involves seeking patterns across multiple cases. In this case study of an organization, the level-three questions examined patterns of self-directed and team-based learning across the four focus groups being interviewed.

First-level interview questions asked of focus group participants, anticipating individual response, included:

1. Give an example of a recent team-based learning activity that one of you has recently engaged in.

2. Give an example of a recent learning activity you undertook as an individual.

3. Have you used CBT Nuggets this year? [Note: This is a web-based self-directed learning program focused on technology. We hold floating licenses for this program.] What is your choice for a learning activity? If not, why?

4. What type of books or journals have you read recently?

5. What blogs do you read regularly? Do you author a blog?

6. What resources are important to meeting your learning objectives? Do you have Internet access at home? Is cost or availability of resources an issue for you?

7. How do you teach yourselves new technology such as Windows Server 2008 or server virtualization?

8. Describe one of your development objectives for 2008.

9. How does the team or organizational culture support or inhibit self-directed learning?

10. What was your most pleasurable learning experience this year?

Second level questions, according to Yin's (2003) definition, are the specific research questions to be answered by the study:

- How is self-directed learning used in this software quality assurance organization to meet continuing professional education needs?

- What is the role of team-based learning to meet continuing professional education needs?

- What barriers or enablers to continuing professional education exist in this organization?

- Who establishes the learning objectives for continuing professional education? Are the objectives learner-centered and learner-defined?

- How are continuing professional educational theories reflected in the participant feedback on learning objectives?

As a secondary data collection method, I collected and reviewed the learning objectives established by the software quality professionals and their managers in January

2008. This enabled me to verify the information provided by focus group participants, to determine if the objectives were learner-defined, and to identify key learning themes.

As mentioned previously, focus group interviews were digitally recorded and transcribed. Transcripts were reviewed by one representative of each focus group for accuracy.

Analysis

A case study database was created for use in conducting a constant-comparative analysis of the data from the interviews. According to Merriam and Simpson, the constant comparative analysis method involves four stages.

In the first stage one compares incidents, generates tentative categories and/or properties to cover the incidents, and codes each incident into as many tentative categories as are appropriate. The researcher also records in memo form any insights that occurred during the comparison of incidents." (1995, p. 116)

I coded each expressed, unique idea or theme related to self-directed or team-based learning. These codes were written on hard copies of the transcripts next to the related section. According to Hewitt-Taylor (2001), codes are generated from the information gathered and are not predetermined. Glaser (1965) recommended that the researcher, while coding a category, compare it with previously recorded incidents in the same category. "This constant comparison of the incidents very soon starts to generate theoretical properties of the category" (Glaser, 1965, p. 439).

The second stage of the constant comparative analysis method involved the comparison of the categorized ideas or themes with the properties of the category

(Merriam and Simpson, 1995, p. 116). Glaser (1965) stressed the increasing comprehension of the properties of a category with the constant comparison of incidents. In fact, Glaser (1965) suggested that one might find that some categories become integrated with others. In this stage, I reflected on how the incidents relate to categories, and how new categories emerged or were combined. Notes were made on decisions related to coding and categories. With regard to coding and categorizing the data, Hewitt-Taylor (2001) stated, "it is important not to lose contextual and descriptive elements of the data, which add to the transferability of the research" (p. 43). Accordingly, I ensured traceability from the categorized data back to the original transcripts through the creation of an Excel workbook to represent each idea or theme and representing the text of elements or quotes for each focus group. This enabled me to review ideas and themes across the four focus groups.

The third stage "is characterized by the delimitation of the theory" (Merriam and Simpson, 1995, p. 116). This stage emphasized possible hypotheses and reviewed the fit of the data within the framework of the theories. Glaser (1965) believed the delimiting occurs with both theory and the original list of categories. As more incidents are reviewed and coded, it is more likely the changes to the categories will become smaller. Also, one might find a smaller set of higher-level categories (Glaser, 1965) within this stage of the constant comparative analysis process. It is during this phase that the scope of the applicability of the theory becomes more evident. I identified several key strengths or concepts for self-directed and team-based learning in this software quality organization during this stage.

According to Merriam and Simpson (1995), the fourth stage of constant comparative analysis involves the development of the theory from the data and memos (researcher notes when reviewing the data). Glaser (1965) believed that the insights in the memos reinforce the categories or themes. At this phase of the analysis, the categorization helps refine the theory and provide a framework for documenting the theory or findings. It is important to provide illustrations from the transcripts (coded elements) to support the theory or findings, since qualitative research benefits from such points to establish credibility. The refinement of this constant comparative analysis occurred during the development of the Excel workbook and the review of the learning or development objectives.

Institutional Review Board

Institutional Review Board approval for a modification to an existing study, Continuing Education for Software Quality Assurance, #82927-2, was obtained prior to conducting any focus group interviews. A narrative of the research study (Appendix A) and a set of interview questions to guide the focus group sessions were approved before scheduling focus group sessions. Informant participation in the focus groups was optional, and informed consent was obtained prior to conducting the focus group sessions.

Researcher Insider Position and Statement of Credentials

As an interviewer/researcher and leader of the targeted quality organization, I have the role of a participant in the organizational culture and a participant/facilitator in the focus group dialogue. It is important for me to be aware of my values, biases,

experiences and influence. I have used several methods to assess the participant feedback including reviews of transcripts by one member of each focus group, a list of interview questions to guide the focus group discussion, and a review of employee developmental goals and learning objectives established through the annual review process. My knowledge gained within the industry provides me with comprehension of the culture, terminology and objectives. As an insider and participant, I am able to interpret meaning more effectively than one from outside the profession. It is through my lens of experience within the software industry that I analyzed the data obtained from this research. My experience includes: leadership roles in eight software companies; American Society for Quality certifications in quality management and software quality engineering; and a history of teaching software quality assurance practices to those desiring certification. My professional development and continuing professional education have centered on quality management, software quality, adult learning, and customer service. Following is a list of my experience and credentials:

- Certified Quality Manager, ASQ

- Certified Software Quality Engineer, ASQ

- Executive Director of Quality, a central Indiana software company, 2001-2009

- Product Quality Manager, Tivoli Systems, 1999-2001

- Quality Manager – Software Engineering, Raytheon Technical Services Co., 1998-1999

- Programs & Planning Engineering Manager/Quality Manager, Apple Computer, Inc., 1986-1997

- Product Documentation Manager, InteCom/Wang, 1985-86

- Software Certification & Support Manager, DataPoint Corp., 1979-1982

- Senior Technical Writer/Software Quality Engineer, Northern Telecom Corp., 1977-1979

- Ed.D. Candidate, Ball State University, 2009, Adult, Higher and Community Education, cognate in Executive Development.

- M.A., Ball State University, Adult and Community Education, 2004.

- B.A., Michigan State University, 1977.

- IAB Chair, Software Engineering Research Center

- Senior Member, American Society for Quality

- Member, National Association of Female Executives

- Member, Greenleaf Center for Servant Leadership

- Instructor, CSQE Prep Class, ASQ, 2000-2009

- Guest Speaker on Quality Management and Software Quality, Ball State University, Purdue University and University of Texas graduate programs, 1992-2009.

Throughout my career I have had a passion for strategic planning, continuous process improvement, the customer experience, and self-directed learning. As my career has evolved, and as I have learned new theories, techniques and methodologies, I have emphasized mentoring, coaching and teaching in my role as a leader of software organizations. Development of talent has been critical to the achievement of business

objectives. For this reason, understanding continuing professional education within the profession has become a personal goal.

Summary

The strength of my research approach includes my knowledge of the software quality professional roles, my participant and insider position within the organization, and my ability to describe the self-directed and team-based learning activities of software quality professionals. This group has not received much study and no prescribed course of CPE exists. My insider status within the organization provides me with the benefit of understanding the organizational, technical, and process changes that have occurred over the past eight years in the organization. My insider status also provides me with the ability to recognize the context of employee comments and examples during the focus groups.

This is a constructivist orientation to research; an attempt to construct new knowledge of methods of meeting continuing professional education needs in software quality. Young described the future of continuing professional education as "An eclectic model utilizing just-in-time, learner-centered, practice-based, technology-driven environments" (1998, p. 139). This software quality assurance organization provided just such a model.

Merriam and Caffarella stated, "Because the knowledge base of the critical practice of self-directed learning is limited, studies need to be completed to see if this practice is carried out, and if so how. Studies of this practice could be done through case studies and other qualitative methods" (1999, p. 313). In using a case study approach, my main emphasis was on providing a thorough description of the organization's self-

directed and team-based learning activities and objectives and the culture or support system.

As I currently work within the practice of software quality, I was diligent about considering my values and potential biases when developing the interview questions and reviewing and describing the participant feedback. The interview questions were reviewed by subject matter experts, the focus group transcripts were member-checked, and annual appraisal information about learning objectives was used to compare to participant-reported objectives.

Chapter Four: Findings

Overview

In this study, the feedback was collected through a series of four focus groups with software quality professionals at a central Indiana software company. The company develops and sells software used by Information Technology organizations. I lead this software quality organization, and the organizational participants included thirty software quality professionals. Five of the participants were women and three participants, all men, were African-American. For five participants, English was a second language.

The participants in the focus group sessions were open to sharing their learning experiences with me and engaged in dialogue and clarification with their peers. I was delighted to listen to their stories of how they obtain the technical and process knowledge needed to perform their jobs as I gained new insight from their experiences. I used a descriptive and exploratory approach to my review of the feedback obtained from the focus group sessions.

To provide context for this discussion, the assumptions of this research are reiterated: self-directed learning is an important method of valid CPE for the software quality professional; self-directed learning by teams enhances individual efforts to improve professional competence; and cultural support systems and resources are important to the achievement of learning activities. These assumptions are supported by the research findings presented in this chapter.

The study of self-directed and team-based learning activities in this organization provided the opportunity to learn how these software quality professionals keep abreast of the changing technological and process landscape to meet the customer requirements for high software quality. This chapter explores the relationship of these findings to self-directed and team-based learning theories.

In answer to the question 'How is self-directed learning used in this software quality assurance organization to meet continuing professional education needs?' I noted several common themes across the focus groups as I performed the review including:

- The importance of access to a 'significant peer'.

- The central role of the Internet as a means for learning through 'Googling'.

- Load and Learn, a experiential (and trial and error) learning practice of installing a required test application and trying to figure out how to configure and run it through the user interface alone.

- The benefits of the manager/project manager as facilitator of adult learning activities and resources.

A common theme regarding the role of team-based learning to meet CPE needs was the reported pleasure of learning within a team or group. Participants reported that they enjoy learning from others' experiences in a group setting. Additionally, rotating the role of group leader/teacher provided the opportunity to improve learning and retention.

These themes reflect a unique trend in continuing professional education for the software industry. One often thinks of continuing professional education as routine workshops driven by the efforts of an externalized professional body or organization, with certification or licensure (and the maintenance of same) as the objective for

validating professional competence. The findings of this case study describe a more

informal continuing professional education model that is learner-centered rather than

focused on the objectives of a professional organization. This model is driven by use of

the Internet, self-directed and experiential learning styles, and access to significant

peer(s) to support just-enough and just-in-time learning and application of learning. The

managers of software quality professionals play an important role as enablers and

facilitators of adult learning and a supportive culture. Supporting statements and data

from the focus groups follows, organized along the lines these themes.

Significant Peer(s)

Access to knowledgeable, experienced peers who are open to questions provided

a key-learning vehicle within the organization. Many participants reported the

interdependence of software quality professionals with the sharing of domain expertise as

critical to the learning experience. It was reported that information access is greater

within a team than across team boundaries. Regarding learning from a peer, one

participant reported, "that's probably one of my biggest ways that I learn these days"

(Group Two). Group One participant stated "I relied more on co-workers who already

had some familiarity with the operating system" and another stated, "You need somebody

who's already slogged their way through it and made some notes…[It's] helpful to talk to

other team members and get 'where do you think I should look next?' (Group One).

One interesting perspective described the reliance on peer knowledge as, "It's an

organic process…getting referrals from one person to the next to find information"

(Group One). What they describe is like following a scavenger hunt, working from clues

through collaboration with others toward a goal of being able to complete the test activity or investigation. The customer also operates as a significant peer. In solving customer problems or defect scenarios, software quality professionals have the opportunity to increase their knowledge and experience, and they related these interactions to the principal investigator as learning experiences. A participant in Group Three cited comfort level with a co-worker in making a decision to seek peer advice. While some participants sought information or expertise from a peer prior to engaging in research, others cited that as a vehicle for learning only after working through issues independently. "You come to a point where you have an issue and you feel like you've done pretty well on your own to figure it out and stuff, and then you go ask somebody else" (Group Three). Conversely, in the same focus group, one participant said, "I think it's your first thing, to ask somebody else who knows so you don't waste time trying to figure it out." Consulting with a significant peer is a form of data mining ("to find out if there was anything that he could offer for it", Group One).

There is no formal etiquette evident in the organization regarding when to ask a peer for assistance. The success of this learning technique, consulting with the significant peer, is that participants believed they could meet their learning needs in this way. Group Four participants stated that peers are an important resource in meeting learning objectives. The co-location of project team members was also cited as an enabler of such communication among peers. The downside of being the significant peer, for one participant, is redundant questions from people and the amount of time spent supporting peers.

In a tribal sense, employees become aware of and rely on those who hold subject matter expertise within the organization; however, there is no formal recognition or communication of these the 'go-to' people. Improved definition and acknowledgement is needed of the role that the significant peers, or mentors, play in the continuing professional education process conducted in the software or technology workplace.

The Internet

Googling. All of the focus group participants reported having access to the Internet from home and most participants reported using the Internet as a key, if not primary, resource for self-directed learning. I was surprised at the emphasis on Internet searches to find information to solve technology problems. 'Googling' was a term for this predominant learning style. "I call Google Man," stated one participant (Group One) to research issues and problems. The Internet is not without its shortcomings, however. There are inaccuracies in online information that can cause confusion in the learning process, according to focus group feedback. Websites for Microsoft products can present information as "happiness and roses" and fail to include information about the downsides of the product or key complexities in the configuration process. Participants who develop software reported the use of the Internet to look for programming examples as a means to validate their programming decisions or approaches. Several participants also emphasized the need for accurate information and believed that the Internet provides timely access in comparison to books or reference manuals, especially regarding server operating systems. They reported that books or reference manuals are quickly made obsolete by new product

releases, such as operating system service packs, and therefore unreliable resources to get

timely information.

It was also reported that the Internet provides access to information that is

unavailable through other methods. One participant provided an example of the Rubik's

cube. His son recently received a Rubik's cube and, rather than spend hours attempting to

solve the puzzle of putting it back together correctly, he quickly found a solution video

on U-Tube and solved the puzzle within minutes. Prior to the existence of the Internet

and vehicles such as U-Tube, one was forced to rely on trial and error or significant peers

for solutions to such problems.

Blogs. Similarly, participants reported using Internet searches to seek individual

blogs that provide descriptive information about how to solve programming problems.

One participant frequently refers to blogs that describe coding disasters and he uses this

information to learn from others' mistakes and learning experiences. Exchange Experts

(http://searchexchange.techtarget.com/expert/Knowledgebase/) is a resource to which the

company holds a subscription. It is an indexing and searching tool that enables the user to

seek information about Microsoft Exchange database-related questions and is heavily

used by participants who must work with this application. The focus group participants

reported that they do not pose questions in Exchange Experts or other similar web tools,

as they "want immediate results". They don't pose questions due to their view that they

have no time to wait for an answer (pressure to resolve problems immediately). However,

they did report that they are rarely the "pioneers you think you are" and that they usually

find that someone else has already posed online questions and answers to problems they

face at work. "Rarely does it seem you're the first person to ask a question" (Group One).

Another participant indicated that "We're the kind of guys that can answer the

questions", implying that the software quality professional in this organization was ahead

of others in terms of depth of knowledge and experience with complex problems.

Internet searches, regardless of the search engine used, provided participants with

links to blogs where one could find valuable information to solve work-related

technology problems. One participant (Group Two) reported authoring a blog as a means

for improving his knowledge. He recently wrote about version control and found that the

experience of writing and re-writing the article enhanced his understanding and expertise.

As well, he found the responses to his posted article within his blog also informed his

learning. Blogs can be used as an interactive means of enhancing learning if one can

afford the time to wait for responses.

A blog called 'Worse Than Failure' was a resource for participants in Group

Three as it describes failures in code design and occasionally quality assurance-related

failures. It is reported to have a humorous bent to it and is interesting, factors that the

participants indicated are important to engagement through this medium. 'Sutter's Mill',

a C# blog authored by Herb Sutter (http://blogs.msdn.com/hsutter/),was reported to be a

valuable source of learning through a blog. Group Four reported using the Microsoft

Exchange blog authored by developers at Microsoft, 'You had me at Ehlo'

(http://msexchangeteam.com/) as a source of independent learning from those considered

to be experts in the domain. Additionally, Microsoft's data protection manager's blog,

SQL Server Authority (http://www.sqlauthority.com), and blogs hosted by the

participants' company were identified as important resources. One participant blogs his

personal day on Twitter as a learning experience.

The influence of the Internet. Does management recognize the predominant use of the Internet as a means for conducting continuing professional education in a self-directed manner to achieve business results? The answer relies somewhat on the organizational culture and whether or not management views 'surfing the web' as a lesser activity than coding or testing the application under development. It may be difficult for an authoritarian manager to see time spent 'on-line' as an element of overall employee productivity. A conservative culture may view such activities as time wasted while a more liberal culture may recognize the overall benefits as time well spent, especially when problem solving is the focus of much software quality tasking.

Access to the Internet enables and enhances research from home or at work. In this organization management has the opportunity to reimburse software quality professionals for their ongoing home Internet expenses up to $50 per month. This is a benefit offered on a selective basis and to less than twenty percent of the employees. The company does not have an official policy with respect to such reimbursement for employees who work mainly from an office location. The current approval process within the organization centers on the amount of project-oriented tasking (development or testing) that will likely be performed outside the workplace. Employees are offered the opportunity to work from home one day per week. Management consideration of the benefits of Internet access for home-based self-directed learning could bridge the gap identified by participants in having to perform learning on personal time. The benefits of Internet access include the ability to conduct self-directed learning and research of technology problems when time permits (as opposed to when location permits). The provision of hosted cloud computing environments for executing labs or other learning

scenarios could potentially revolutionize self-directed learning of technology from remote locations. High-speed and roaming Internet access and suitable home-based computer equipment for employees, funded by companies as a training benefit, could also enhance self-directed learning through providing greater range of opportunity.

Load and Learn

Trial and error approach. Group One participants described using a trial and error approach to learning how to install SQL 2008 in clusters on Windows Server 2008 operating system (WS2008). One participant described this as "guided" trial and error through the use of referral to a significant peer, Internet searches, and webcasts as a means to get through blocking issues. There was an emphasis on building on past experience and knowledge. "Use existing knowledge. When that fails, start searching on the Internet." One participant reported, "I found I'm more of a hands-on type of person" in undertaking new learning. The learning was described as self-directed but prompted by a project, meaning that being assigned to a new project provided the requirements for learning (for example, learning the new WS2008 operating system when the project undertook support of that version). Another participant indicated that "First thing, I look for people within my team" that have the needed knowledge or information, rather than dive into trial and error. Learning through experimentation with the targeted product was a common theme of discussion. It was emphasized that "occasionally you'll have to know the right question to ask" and that the search refined the questions.

Group Two participants also described using an experiential approach to learning by "setting up [my] own test environment and just goofing around with it" and trying

various scenarios with the product to learn how the product would respond. A significant finding was the importance of learning through trouble-shooting customer-reported issues. "You have to trouble-shoot that as a point of learning", reported one participant. "Then the investigation itself is a process of learning." In this focus group, being responsible for determining the root cause of customer issues was a key driver for new self-directed learning activities and the resulting learning increased professional competence.

Applying new learning. Group Three reported yet another perspective on learning preferences by identifying the importance of having to apply the new information within a project or assignment. One participant stated that, "the real learning comes when you apply it." In reference to learning C#, a new programming language, a participant emphasized that when you "do something and reliably repeat it – that counts as learning". Additionally, a participant indicated that, "when someone comes and asks me a question about something, they're not bothering me or anything. It helps me solidify what I already know", so participants can improve or increase their learning when teaching others in the workplace. One participant revealed that reading or referencing books is a key learning preference when more in-depth information is needed, especially about a programming issue.

Research skills. The participants in Group Four provided feedback that confirmed the preference to build upon one's prior experience and knowledge through trial and error. However, there were some new revelations regarding learning preference in this group. One participant stated, "I think the one skill they [the best tech people] have to develop in this business is to figure out how to get the answers. Figure out how to do the

research." This is an interesting perspective on learning within the profession – the need to understand how to approach the learning experience repeatedly and successfully by figuring out how to perform research. Self-directed learning approaches were predominant in this group, complimented by access to a significant peer who held knowledge or experience. "I learn more on my own and if I have questions that I can't resolve, I'll go and ask. I learn that way and I retain things longer and [if] I go ask someone right away without researching it on my own I'll retain it for a short period." One participant stated that his passion was for learning in new areas of technology and that this had become evident when he was recently asked to test products from newly acquired companies. He described the experience as "Learn it, understand it, and make recommendations". Another interesting outcome from this group was the stated preference by one participant for job shadowing as a means of learning.

Learner-Centered Continuing Professional Education

Self-reported development or learning objectives were discussed in the focus groups, in the context of individual participant plans to meet the objectives. A summary of the development objectives and stated plans is provided in Table 2, and principal investigator observations follow.

Development objective	Planned method of meeting objectives
Learning C++/C# programming languages	Regularly reading 10 minutes a day from a book; tracking reading time on calendar
	Trouble-shooting one's code/by experience
	Using Internet/Googling to resolve questions and see examples of code
Passing the Certified Software Quality Engineer (CSQE) from the American Society for Quality	Studying the primer
	Registering for the exam
Attending a software quality class and developing test cases from what was learned	Identifying a class and enrolling
Improving team's quality assurance processes	Using SharePoint server to generate templates for sharing project test plans and objectives, for tracking test completion and issues
Implementing a robust integration of the automated test framework with ESX Lab Manager, virtualization	Hands-on "learning a whole swath of new information"
	Using these solutions on-the-job to solve problems and test projects
Learning and using InstallShield	Job shadowing two developers
	Porting code from Visual Studio installer to InstallShield
Applying and automating enhanced statistical information on performance test reports, and learning to use the new Excel API	Applying programming techniques learned in seminar
	Mentoring from his/her father who is a Six Sigma Black Belt
Studying Microsoft Vista operating system as part of the WS2008 certification body of knowledge	Reading reference manuals from Microsoft
	Making time for oneself a priority
Taking the actual test for the MCSE with an Exchange emphasis	Taking one test every other month
Learn more about the development process and learn more about automating things	Job shadowing with adjacent developers through scheduled time together

Table 2: Self-reported learning objectives.

Some participants reported specific self-directed learning activities as the framework for meeting the development objectives. For example, such activities included setting aside time to read manuals, studying a primer, job shadowing and porting code to a new language. Access to mentors or peers was important to making progress when confronted with blocking issues. There were reported problems in making self-directed, individual study a priority; one participant stated that he usually puts others' requests for assistance ahead of time for self-study. There was a pattern of deferral of time for study and yet this was complemented with a job shadowing or mentoring alternative for reaching development objectives.

The self-reported development objectives address both process and technology, or software application, learning experiences for the participants. The certification-related objectives involve learning from documented bodies-of-knowledge materials while the process objectives tended to center on application of new learning on-the-job. Where the objective involved using a new application (SharePoint, InstallShield, Excel, C#, etc.), the method of learning was very hands-on. Access to resources to meet development objectives was not an issue for the participants.

To verify the authenticity of the reported development objectives, the principal investigator compiled a list of participant development objectives as defined with their managers in January 2008 (and documented in employee performance appraisals); see Table 3. Management defined only four of the development objectives (increasing automated testing and improving organization of work). The learners established the rest of the objectives. This is in line with Houle's view on the importance of learner-centered CPE.

Master Windows SharePoint Services 3.0
Master Microsoft SharePoint Office Server 2007
Learn SQL Clustering
Master SQL 2005 Server
Obtain certification on MS Office 2007
Work with various test teams to develop test objectives documents
Attend SQA Workshop
Design/Develop Test Cases
Go back to school in a graduate non-degree program in Computer Science
Attend Microsoft cluster class
Attend any training/seminar regarding server and network configuration
Increase automated testing
Get involved with code reviews
Improve trouble-shooting techniques
Participate in the C# study group
Document new concepts learned in classes, how they were applied, and the benefits gained
Attend several software testing seminars/webinars
Read Cem Kaner's book "Testing Computer Software", 2nd edition
Attend some Microsoft Windows User's Group meetings
Obtain Windows 2003 MCSE certification
Complete CCNA certification
Learn to run the test automation tools
Learn clustering through CBT Nuggets
Learn SQL 2005 through CBT Nuggets
Learn WSS through CBT Nuggets
Cross-train with peers to avoid single point of failure in team
Improve organization of work
Exchange 2007 clustering
Exchange 2007 training
Learn SQL clustering
Learn SQL new features

SQL MCSE certification
Linux series videos on CBT Nuggets
Gain extensive knowledge of VMWare ESX 3i
Take internal product training classes
Agile software test techniques training
Management training
Upgrade MCSE to Windows 2008 level
Pass 2 upgrade exams to Enterprise Server Administrator certification for WS2008
Further education toward Bachelor's degree in Business Information Systems
Learn WS2008, IPv6 and Hyper-V functionality
Take a technical writing class
Take CSQE exam
Learn transactional file functionality of WS2008
Improve my attitude
Learn to deal with frustrating people more effectively
Take exploratory testing class
Oracle 11g DBA certification
SAP training and certification
To improve my relationship with peer
To mentor staff more effectively

Table 3: Learning Objectives Captured From Annual Review Data.

Not only do the pre-defined development objectives reflect the learning activities related by the focus group participants, but the appraisal data also reflects an engagement by the professionals to define their own goals. Some teams of software quality professionals had shared goals established by management including expanding use of test automation, using CBT Nuggets to learn about technologies, and improving test processes used by the project. More frequently, the software quality professionals identified their own learning and development objectives as well as the resources

identified to meet the objectives. Many methods deployed included self-directed learning activities.

Manager as Facilitator

   Workload. The organizational culture as reflected through the actions of engineering management, and especially project managers, was identified as a political element (Owenby, 2002) that either creates barriers to or enables self-directed learning for the software quality professionals. Participants reported that project managers pushed a "coping-based" style of learning to meet test requirements rather than "taking in new technology" (Group Three). Most participants reported that there was no time allocated in project schedules for learning new technologies for a project and that learning was to occur on their own time, after hours. One focus group interchange revolved around a team lead having requested that a tester not participate in the (one hour weekly) programming study group due to project schedule concerns. One participant described the supervisor as a "meta-expert" for referrals to individuals who have tribal knowledge to expedite the learning experience. Some participants reported a confidence issue regarding the inability to invest the time to learn new applications in depth, to the administrator level of skill. The comments reflected a frustration about achieving mastery of new skills to the extent desired.

   Time pressure. Time pressure within project teams, especially over the past two years as the organization moved from a functional organization design to a matrix-managed project orientation, was reported to be a key facet of the organizational culture. A functional organization is one that is centralized around a particular skill set. A matrix

organization aligns around the product being developed and contains representation from each of the needed functions to achieve the business objectives. Project managers lead these matrix teams. The product release schedules pressured the software quality professionals to compartmentalize knowledge and learn only what was needed to "get the job done". "There is no time allocated for learning. Time is expected to come out of personal time" (Group Two). The participants discussed Microsoft as an example of a company culture that does not value learning within the project. "I wonder how much you want to expect people to go home every night and use non-work time to go study things. I mean, how often do you want to bring your work home?" (Group Three). Companies that allocate time for learning are preferable and "more attractive as a job". Some participants indicated that there are unrealistic expectations by project managers regarding learning curves for new projects, while others reported that the learning curves are an unstated expectation of transferring to new projects and that teams are open to enabling that learning. A strong cultural support of self-directed learning was reported but the emphasis is on learning on one's own time. "It is expected that you'll talk to team members about things that don't make sense to you" (Group One). There were positive references to a internal program that had been previously used to track two hours per week of workplace learning activities and the associated value of providing the time and validating the investment in learning. The culture was perceived to have shifted negatively over the past two years in this aspect.

Within the context of the agile software development process, the project managers have the opportunity to allocate time for learning as defined tasking during the planning of agile sprints, or development cycles. Participants expressed the desire for

team-based learning when moving to the use of new technology, in addition to time for self-directed learning to master the requisite new skills. Within industry there is a common expression that what gets measured, gets managed. If the measures of software development success center mainly on schedule achievement, other important and unmeasured elements of sustainable practice may be overlooked or negated. It is advisable that project schedules are not based wholly on tasking defined as features implemented, defects found or fixed, and tests passed. Project schedules should also account for time devoted to self-directed learning, team-based learning, and communication with significant peers.

Important cultural characteristics. Daley (2002) discussed cultural characteristics that influence the professional's use of new information. One of these characteristics was the level of independence and autonomy of the learner. The participants in the focus groups indicated a high level of independence and autonomy for self-directed learning within the culture, but also stressed that there must be a reason for the learning. The project team goals, and associated new technology, often provide the reasons for the learning while sometimes the goal is to solve a customer problem. Associated cultural supports included the use of stand-up meetings from the agile software development method, the assignment of mentors to new employees, and co-workers that are open to questions. Some participants stressed the importance of knowing programming and logic as a baseline for being able to learn effectively.

One surprising cultural barrier was revealed in a discussion about the "Queen's English", or English as a second language for the software quality professionals. Self-directed learning was preferable to two participants due to the difficulty in keeping pace

with instructor-led delivery in classroom settings. The project managers who lead the study participants are all white males in their thirties from the Midwest. It is important that such project managers are educated in diversity, language differences, and cultural styles to properly consider the variety of learning or participatory needs of employees.

Additional comments regarding the excitement of getting to work with new technologies and the importance of individual domain knowledge are also reflective of the culture within which these software quality professionals operate. Several participants reported feeling very excited when faced with new learning opportunities, such as virtualization technology, and felt that these opportunities increased the desire for learning. Participants also felt that it was critical within the engineering culture to develop personal expertise and knowledge in a specific technology domain to be secure regarding their role and to be valued within the organization by peers and management. "So you must remain fluid and you must keep up or be left in the dust. So user oriented learning is realistically the best way to go" (Group Two).

Co-location of matrix teams. Several participants identified the co-location of project team members as a critical cultural support for learning. Co-location involves the physical placement of team members centered on project assignment. Project managers, developers, and software quality professionals sit near each other. Informal learning through interaction with others working on the same project occurred when team members were co-located. One participant stated that, "Co-location has worked…a lot of education takes place around people's desks" (Group Four). The project teams had been co-located within the past year after years of being located according to function with developers on one wing of the floor and software quality engineers on another. Project

managers and team leads were interspersed in offices. To some extent, team members now sit in close proximity to each other. The findings on the benefits of co-location of project team members are in conflict with current trends toward globalization of corporate resources and the outsourcing of development and test activities. These findings suggest that there is more and better communication when team members sit near each other, leading to greater comprehension and productivity.

Ancillary Findings

Programming and Logic Knowledge. Another key finding of this research, identified by Group Four, is the importance of today's software quality professional knowing computer programming and logic. "It's invaluable to comprehending how to do one's job", reported one participant. Another reported that, "Especially if you're going to write scripts, if you're going to work on automation, it really helps to have that high level understanding." Participants described the helpfulness of this knowledge, both individually and in interaction with software developers, when seeking the root cause of a software defect. From a management perspective, this finding can be applied in various ways. Through base-lining a software quality job requirement that candidates hold a programming background, potential employees can be screened for prior programming education, experience, and skill. Managers can assess existing employees on their current programming abilities, and create learning objectives and opportunities to enhance their knowledge and skill (continuing professional education). Additionally, managers can prioritize and allocate time and resources for self-directed and team-based learning to achieve greater programming proficiency within the organization. Such proficiency is

believed by the participants to lead to greater productivity and success in their roles as software quality engineers.

Journals. Journals were not a critical source of information for focus group participants. Group One did not report any journals read by participants. Group Two identified Wired, Information Week (http://www.informationweek.com/), Linux Weekly News (http://lwn.net/), and the Linux Hacker's Journal (http://www.linuxjournal.com) as occasional sources of information. Group Three reported a broader selection of journals read by participants including computer science and science journals, *File System Forensic Analysis* by Brian Carrier, OSR Online (http://www.osronline.com/), and Microsoft Developers Network (MSDN) developer journals. Group Four participants reported reading Software Test and Performance (http://www.stpmag.com/), a monthly online magazine, and Software Quality Journal and Quality Progress from the American Society for Quality (http://www.asq.org/pub/). Additionally, the participants reported reading OSR Online (http://www.osronline.com/), the Microsoft driver development organization's online journal; Storage Magazine (http://searchstorage.techtarget.com/), an online journal regarding backup, de-duplication and archival products; and electronic monthly newsletters from the teacher of the agile test techniques class taught onsite this past spring. While journals were reported to be an interesting and enjoyable reading activity for participants, they did not report relying upon this medium as a means to solve technology problems. Such journal reading appears to be a diversion from tasking or a relaxation exercise for participants.

Books and manuals. Books and manuals were not reported to be a critical element of self-directed learning for participants in the focus groups. Several participants

indicated that operating systems technical manuals are quickly stale-dated and therefore

unreliable resources. Some participants refer to programming reference manuals

specifically to clarify syntax questions but they do not read such manuals cover-to-cover.

Reference books cited by participants include *Head First C#* by Stellman and Greene

(2007), Mark Minasi's writing on WS2008 (http://www.minasi.com), and Micosoft

Certified System Engineer (MCSE) manuals, and PowerShell manuals

(http://www.microsoft.com). "The downside of books, once they're printed they're out of

date" reported one participant. "A book might be a good starting point…critical things

change and the book's out of date" (Group One). Group Two reported that book prices

are often too high for individual purchase and that the price range of books is important.

"Books are expensive, they can be really expensive." (Group Two). One participant of

Group Two summarized his views regarding books effectively – "If you're trying to find

out how to administer ESX [a virtualization operating system], those books don't keep

up. But if you're trying to find out the principles of virtualization, a book is okay." One

participant in Group Three reported, "I prefer a book, something I don't have to log into.

Just grab the book off the shelf." Group Four participants did not report using any books

or manuals to meet their workplace learning requirements.

Team-Based Learning

Books did have a place in team-based learning experiences, or classes. An internal

study group, organized and facilitated by a human resources employee, was based on

Leading From The Front by Morgan and Lynch (2006). The participants in this study

group reported that they enjoyed the reading assignments and took pleasure in learning

from others within the group. Focus group participants reported a variety of recent group learning experiences with both pleasure and frustration. *Agile Test Techniques*, provided onsite by ASPE, provided some new testing methods to participants and the group learning experience was enjoyable. Participants in this class, and a *Test Management* class (offsite), reported the value in learning from others' experiences and the integration of life experience into the learning activities. One of the downsides of classes was that "You need time to process new information" (Group One). "You're going to be discarding things and not even hearing them while you're trying to process previous information" (Group One). Classes were reported as beneficial for the reference documentation that was provided as such documentation can be used subsequently for self-directed learning. One participant reported that "The class [test management] was good but we have bigger brains than what these people have," referring to a self-comparison to government employee participants. He reported that the test complexity and challenges in his work environment were significantly greater than the average student in externally provided classes. This same participant attended local college classes and appreciated the teaching approach as "they try to relate it to your life. So they compare life experiences to the subject which you're going through now." It is not uncommon for adult learners to value the integration of their life experience in learning activities.

A two-day *Agile Test Techniques* class was provided to focus group participants earlier in the year. This class was valued by Group Two participants as the instructor "greatly exceeded what I expected" and "totally changed our thinking together as a QA team…He gave us really clear guidelines on focusing testing where there's problems".

Another Group Two participant reported that the class emphasized "Learning how to fish in the right pond". He jokingly stated "Or learning how to fish in a stocked pond" due to the number of defects to be found in new product testing. A Group Three participant comment regarding this class was that "you learn it when you apply it in your day-to-day work".

Numerous participants related their experiences with certification training programs. These are often referred to as 'boot camps' as they are intensive, short-term learning programs to pass certification exam requirements for specific product vendors. Examples provided included RedHat5, New Horizons, VMWare, and Microsoft boot camps. Participants expressed a sentiment that these were not actually learning experiences due to the compressed nature of the exercises, weak training programs, and the provision of exam questions. Regarding Microsoft boot camps, "They give you test answers and you're supposed to memorize them" and we "basically played World of War Craft the whole time" during the training program. One participant remarked that his money at New Horizons was poorly spent as he later found little respect for the program from prospective employers. Group One participants commented on the difficulty of keeping pace with the instructors in Microsoft certification classes. "They're cramming the whole full thing into your head", remarked one participant. Another stated, "By the end of the day, I'm totally lost". Additional comments included "So it's like drinking out of a fire hose!" and "It's information overload" to describe participant experiences in the Microsoft certification classes. These comments reflect participant distaste for the banking system of learning where the learner is in the role of received knower and the

instructor is attempting to convey a large body of knowledge within a short period of time.

Group Three participants discussed recent positive team-based or group learning experiences. One participant stated that, "the best classes have a hands-on component", reinforcing the importance of learning styles. A recent performance test seminar was valued because the "learning triggered more learning" for one participant. He was able to apply what he learned and this application led to further investigations specific to his product focus (new Excel application programming interfaces). The Indy Tech Fest, a technology workshop and marketing forum offered free in Indianapolis, was regarded as "a day full of geek time" and an opportunity to apply learning to the job immediately.

Group Four participants also referred to the Indy Tech Fest as a recent opportunity to learn more about SQL specifics in a classroom setting, with six sessions or presentations with question and answer periods. An internal study group led by one of the software quality professionals and focused on logic and programming techniques was cited as "good for refreshing prior knowledge" with the stated goal that participants learn to script some of their test tasks. Another team-based study group for Microsoft certifications was identified as a valued class activity because "we self-taught…and rotated that". Each participant in the study group took a chapter and became the presenter for that chapter, thereby rotating the facilitator/leader role within the team and sharing the responsibility for learning and teaching. This activity was executed by a group of software quality professionals and their line manager. Several participants referenced informal presentations made internally by a peer on newly acquired products. Such presentations "spread knowledge" and they are "a chance to allow people to get

introduced to some new technologies". Participants indicated an increased level of knowledge about the products from the opportunity. The presenter also confirmed increased knowledge from having the experience of teaching through such informal presentations. Of these informal demonstrations with peers, one participant stated "they take the rev [revision] one information and not really hand feed it but break it down", making for a valuable learning experience.

Barriers and Enablers to Learning

One of the research questions was 'What barriers or enablers to continuing professional education exist in this organization?' A chronic shortage of time for learning new technologies was cited as a key barrier to learning in the workplace. Understaffing of project teams led to "working in a time-box" (Group One, Group Three). "One problem with this job is that sometimes you learn just enough to satisfy your job…you know what that means?" (Group Four). Another participant in Group Four stated that, "We've accelerated that [work pace] so much now that in-depth research has to be performed offline and you really don't have the time". The investigation of customer-reported maintenance issues was reported to take 75 to 80 percent of one's time, "and that's where the time crunch comes in" (Group Four). Maintenance testing is not accounted for in most participants' workload. The testing of hot fixes for maintenance issues, where a customer is waiting on a fix, was reported to lead to "selective learning…It's learning what you need to know" due to the schedule pressures. A participant in Group Three reported the lack of time for learning as, "So there's not much time for self-learning other than what is absolutely required to get your current task done."

One participant also reported that, "project teams provide no learning activities to support the projects" (Group One). Individual responses during the focus groups clarified that self-directed learning is the means to obtain technology or process knowledge needed to complete assigned tasking, and that such learning is expected by management to come from one's personal time. It was also challenging for participants to get approval to attend scheduled classes, whether onsite or offsite. This resistance from management to allow time for classes resulted in less enthusiasm for initiating learning plans that involve commitments to classroom time.

Affordability of books and media presented itself as another barrier to learning for the participants. "You want to buy books, you need money", reported one participant in Group One. Another participant of that group also said, "Books and media are not cheap". Group Three cited the high cost of technical books and textbooks as a barrier. Group Four identified the cost of purchasing servers and associated hardware as a barrier for home study. The servers are needed for conducting self-directed labs.

There were a number of key enablers to self-directed learning cited by focus group participants, as follows.

- Documenting the learning experience to share with others

- Web/Internet access

- Correct information ("key to find out what I really need to know")

- Agile stand-up meetings

- Peers; Co-workers that are open to questions

- Abundance of locally-offered seminars

- Being able to work with new technologies ("New stuff is pretty exciting")

- A website called actualtest.com, which provides answers to certification exam questions

- The new library in Indianapolis as a location for engaging in searches

- Access to the MSDN (Microsoft Developers Network) site

- Knowing computer programming and logic

There was an excited discussion surrounding the use of the Internet and access to peers. "If you have peers and the Internet, that's pretty much it", summarized one participant from Group Four. "Peers plus Internet equals learning" represented the most common means of obtaining needed information. Focus Group Four suggested the assignment of mentors to new hires as "a point of contact, a single point to ask questions, to help guide them through situations, show them how to set up the lab."

These findings suggest that management facilitate access to resources, including people, and provide an environment that enables and supports interaction. Perhaps it is not the solitary dedication of the low-maintenance employee within the confines of the cubicle walls that defines high productivity within the software development industry. The culture of the gold-collar worker includes valuation of interaction among peers as well as time to engage in self-directed and team learning. Two cultural elements need to change within the industry. When employees are seen surfing the Internet, it should not be presumed by management that they are 'not working'. When employees are seen chatting around a workspace, it should not be presumed by management that they are 'not working'. This research demonstrates that the employees may, in fact, be learning and applying what they learn to their tasking in a just-in-time fashion.

Managers must shift from a command-and-control or authoritarian management style to become facilitators of learning and collaboration. The demand for continued adult learning in the software profession is high and the pace is fast. The adult learning methods documented through this research reflect new ways in which the learners use technology to meet their needs. Leaders within the technology industry must value and foster a high level of access between individuals. They must change their perceptions regarding self-directed learning in the workplace. And they must discard the decades-old mental model of the software developer or tester as a self-sufficient loner who prefers to toil away in a cubicle, requiring little interaction with management or peers. Today's gold-collar worker thrives with healthy inter-dependence and collaboration in addition to time for self-directed and team-based learning.

Relationship to Self-directed Learning Theory

As related by participants, learning objectives are self-identified in the context of the project or assignment being undertaken by the software quality professional and self-directed learning is the most common means of learning. This process meets Houle's (1980) views on learner-centered CPE and his premise that more than half of continuing learning in the professions is self-directed.

The interdependence of the self-directed learning with the 'significant peer' also supports Knowles (1975, p. 18) belief that "There is a lot of mutuality among a group of self-directed learners" and that the learning does not occur in isolation, as many of the terms used to describe self-directed learning imply. One of Knowles' terms, 'inquiry method', seems more applicable to the learning preferences described by the focus group

participants. This is due to the frequency with which the software quality professionals undertake investigations and research to meet the needs of the assigned tasking whether it be, for example, defect re-creation for customers, testing with new applications, or porting code to a new language. Knowles identified and described the support system required for the self-directed learning process (1975). This focus group research activity revealed that participants relied upon "various kinds of helpers, such as teachers, tutors, mentors, resource people, and peers" (Knowles, 1975, p. 18).

Lowry (1989) believed that approximately 70 percent of adult learning is through self-directed activities. The review of self-reported development objectives in the focus groups (p. 52) provides data indicating more than 70 percent of participants are using self-directed learning activities. Only three of the self-reported development objectives described during the focus group sessions identify traditional continuing professional educational goals or activities towards certification. It does not appear that traditional CPE programs as defined and delivered by a professional body are key drivers for self-directed or other learning activities for the participants.

From the perspective of Nowlen's (1988) models for evaluating continuing professional education, the findings from this research most closely align with the Update Model. The Competence Model is driven from job function analysis as the hub. This type of evaluation process is not embedded in the management practices at the organization under study. The current process is a coaching format, usually conducted in conjunction with annual performance appraisals, where the project manager and employee discuss goals and development objectives for the coming year. The coaching is driven from a project/product perspective and usually addresses areas for growth or improvement.

There is no checklist or template to drive the discussion. Alternatively, many employees are proactive at critical self-reflection for identification of personal objectives and ideas for self-development. This supports the position that the Competence Model, which is employer-centered, is not evident in these research findings. There is also broad variety in the technical and process focus of the roles of the software quality professionals in the organization, making job function analysis more difficult to standardize for benchmarking within the organization. The Performance Model is perhaps Nowlen's most robust model for assessing continuing professional education. It incorporates the professional's views on their individual skills and needs in addition to consideration of the impact of the organization. This would include an assessment of baseline knowledge and skills and the challenge of new roles. The identification of the strong benefit of programming and logic knowledge and experience as a key enabler to learning for software quality professionals in the organization reflects a grassroots suggestion of the idea, not a formal baseline or job requirement. Additionally, the participants reported a lack of dialogue or planning within project teams for transitioning to new technology in agile sprints. This data suggests that there is no process in place for addressing the challenges of new roles.

Nowlen's Update Model (1988, p. 24) aligns most appropriately with the research findings. The Update Model is learner-centered and focuses on the need to maintain professional practice or competence. Nowlen described the model as inclusive of informational updates through two to three daylong short courses including professional knowledge updates and technology transfers. Within his categories of 'new knowledge/skills' and 'new technology', I find that the 'Internet and Significant Peer'

model of learning exemplified through the focus groups reflects the use of new technology to individually direct learning via the Internet rather than through formally or professionally defined workshops or seminars. There is, however, a relatively common use of webinars and online learning (e.g., CBT Nuggets) in the organization. The Internet and new associated applications, like Flash, have provided new delivery vehicles for self-directed learning since the publication of Nowlen's models in 1988. There are such rapid changes in technology in the workplace that external professional organizations may face a challenge in delivering current technology information. This was also reflected in participant comments regarding books and manuals becoming quickly obsolete, and the difficulty in obtaining online materials on new operating systems.

The focus group data also provided a means to assess Nowlen's (1988) category of 'A Profession's Knowledge/Skill Base' in the Update Model. Participants provided references to activities related to professional certification goals, learning new programming languages and improving test processes. The self-reported development objectives mainly described goals identified by the participants as adding value to their roles within their project teams and as software quality professionals.

Lowry (1989) indicated that many adults who pursue self-directed learning are attempting to improve their work performance through new skills, knowledge and attitudes. Lowry defined roles for educators and institutions, which are applicable to those who manage software quality professionals. These roles include being a manager of the learning experience, provider of context for the learning activity, teacher of inquiry skills, advocate for underserved populations, planner for objective setting, developer of instructional materials, promoter of learning networks and study circles, and leader in the

establishment of ethical behavior and trust. A review of the data obtained from the focus groups indicates only a casual embracement of this role by management for the target organization. One participant described the supervisor as a meta-expert for identifying peers with needed knowledge. The annual appraisal process provides an opportunity for dialogue about learning objectives and training needs between project manager and software quality professional. Much of the participant focus is on learning activities in support of product development and testing goals. A participant of Group Two indicated that, "self-directed learning is expected [by management]". Group Three identified that companies that allocate time for learning are "more attractive as a job, too. You want a job that lets you leave your work at work and have a life outside of the job". The participants described a work culture that favored learning on personal time. They also emphasized the barrier to allocating time to learn new projects and technologies when moved between project teams.

The focus group participants described a culture where peers take responsibility for sharing the role described by Lowry (1989). Peers suggested and led study groups, enabled job shadowing, provided informal technology presentations, served as advisor, and taught others concepts learned at offsite training. There is a spirit of collectivism within the organization as software quality professionals share knowledge, learn from each other, and gain pleasure from team-based learning opportunities. While some team-based learning activities are planned by management most are initiated at the grass-roots level.

Relationship to Team Learning Theory

Collaborative learning. Buffington (1998) studied self-directed team learning experiences in the workplace. Buffington's research supports collaborative learning as a means to "more efficient and effective processing and retention of information" (1988, p. 76). This organizational case study provided insight into several key team-based and collaborative learning activities undertaken by the software quality professionals. Examples include an HR-related study group, externally delivered onsite training (*Agile Test Techniques*), externally delivered offsite training (college classes, *Exploratory Testing*, *Performance Testing*, certification boot camps, Indy Tech Fest), and two internal peer-led study groups (MCSE program and C#). Participants described the value of learning from others within a team, rotating study group leadership, and applying learning in real-time. They reported that, "the best classes have a hands-on component" (Group Three). A hands-on component was present in several team-based learning activities including the C# study group, the performance test class, and the exploratory test class. Team-based learning was reported by the focus group participants to be the most pleasurable of recent learning experiences. Nonetheless, there were reported challenges in prioritizing time for such learning within the agile development process and project-team schedules. Management identified the learning objectives for the HR-related study group and the agile test techniques class. Participants who defined their own learning objectives identified the remaining self-reported team-based learning activities.

Workplace culture. Senge (1999) is a proponent of a culture of organizational learning and his research has reinforced the importance of opportunity, resources, and a user-centered learning program. The self-reported development objectives of the case study participants as well as the goals and development objectives identified during the

annual appraisal process provide insight into an organizational culture that is both user-centered and project-centered. While resources are provided for self-directed learning activities there is a chronic shortage of time (opportunity) to invest in workplace learning. New learning is prompted by the need to learn new technologies and skills in support of project goals, as evidenced through a review of the objectives. Participants reported lacking the time to learn new applications in-depth and relied on "selective learning" to be able to meet the "coping-based" learning style required within the project teams. The organization lacks the "white space" described by Senge (1999, p. 43) as critical for thinking and reflecting. Additionally, the software quality professionals do not always have the power to take action on their goals (examples include postponement or disengagement in classes) due to project workload and priorities. They do, however, "focus on learning about learning, in settings that matter" (Senge, 1999, p. 43) through the self-directed inquiries. The participants referred to a prior learning program that was in place for several years, formally providing two hours weekly for learning opportunity in the workplace, with a desire for a reinstatement of the policy. They mentioned the challenges of working in a culture that did not value workplace learning.

The organization under study did not reflect a learning organizational culture as defined by Senge (1999) but emphasized a self-directed learning requirement to be conducted on personal time. As stated by a participant of Group Four, "We've accelerated that [work pace] so much now that in-depth research has to be performed offline and you really don't have the time." Another participant of Group Four stated, "You take your time when you're self-paced but when you're under time schedule you

tend to learn a lot quicker so there is some support to it [self-directed learning], it may not be so in-depth, there's something to it. You fill in the blanks later."

The organizational learning style is more akin to Schön's (1987) knowing-in-action form of professional learning where the learner continuously, and often unconsciously, creates new knowledge in daily activities. This is a form of self-directed learning or inquiry that refers to the "kinds of competence practitioners sometimes display in unique, uncertain, and conflicted situations of practice" (1987, p. 22). The participant examples of 'Internet and Significant Peer' and 'Load and Learn' methods to begin testing with Windows Server 2008 demonstrate this learning style. The use of guided trial and error, and learning from experimentation ('freestyle'), also exemplify knowing-in-action professional learning styles. Other examples provided by participants include autonomous learning, engaging in dialogue with a significant peer, and investigating customer issues. Regarding the inquiry into customer issues, one participant from Group Two reported, "Then the investigation itself is a process of learning." Additionally, a participant from Group Three reports that, "The real learning comes when you apply it". Teaching others was identified as a way of reinforcing learning. As well, the participants indicated that there needed to be a good reason to learn and that the assigned tasking often dictated the learning.

Bouchard's (1996) research identifies several explanations for the existence of self-directed learning including the individual's self-instructional proficiency, personality characteristics, and fortuitous occurrences in the environment. This case study research revealed an organization that values research proficiency, and relies on the availability of the Internet and the 'significant peer' as resources that enhance the ability to engage in

self-directed learning or inquiry. The participants work within a technology-driven

organization and use the available technology to learn about technology changes and

problems – a culture of technology. This, accompanied by an informal planning process

for identifying learning objectives, represents a "fortuitous occurrence in the

environment" that makes the learning process different from the cited government

employees who are working in more bureaucratic environments. This technology culture

also requires that learners take autodidactic leaps (a significant leap in skill or ability) as

described by Bouchard (1996), usually in self-directed learning activities. Several

participants described using an experiential learning process to undertake such

autodidactic leaps, with assists from Internet searches and inquiries to significant peers.

Bouchard described self-directed learners as possessing a strong belief in their ability to

learn autonomously and this was validated by participant input. Bouchard also identified

unusual learning strategies that would be considered diverse and creative as leading to the

autodidactic leap in knowledge or skill. The organization's emphasis on the use of the

Internet, including blogs, as a means to resolve problems, validate approaches, and learn

new information can be counted as a diverse and creative approach to self-directed

learning.

The organizational culture does reflect one that provides resources to support self-

directed learning activities (Wonacott, 2002). Wonacott described the gold-collar worker

as the knowledge worker "whose most valuable assets are problem-solving abilities,

creativity, talent, and intelligence; who performs nonrepetitive and complex work that is

difficult to evaluate; and who prefers self-management" (2002, p. 3). While resources for

self-directed learning are provided in the organization (e.g., CBT Nuggets and Exchange

Experts subscriptions), and the software quality professionals exemplify a number of the

assets described by Wonacott, the lack of time for in-depth learning and team-based

learning highlights the realities and challenges of the work environment. The

organizational culture does provide the workplace flexibility identified by Wonacott as

important to the gold-collar worker: casual dress, part- or full-time telecommuting,

flextime, and challenging assignments.

Chapter Five: Summary

Overview

This study sought to understand how self-directed and team-based learning activities are used to meet continuing professional education needs in the software quality field. Continuous improvement of software quality assurance skills and process knowledge is essential to producing software products that meet or exceed customer expectations (American Society for Quality, 2007). Through the case study of a software quality organization in a fast-paced, award-winning company, I sought to understand more about the barriers and enablers to CPE, and the origins of the CPE learning objectives. Participant feedback was also reviewed in the context of CPE theories, especially those related to self-directed and team-based learning.

A New Model of CPE

The research points to a new model of continuing professional education for this profession, with respect to Internet searches as the primary self-directed learning vehicle, complemented with access to significant peer(s) to work through obstacles or blocking issues. Does self-directed learning provides a source of continuing professional education for the organization? The data suggests that self-directed learning addresses the *technological* aspects of continuing professional education for the organization however *process* learning appears to come from team-based learning activities. Technology learning emphasized software tools and software problem resolution. Process learning

emphasized test techniques and the agile software development process. There was an expressed need for project-oriented team-based learning for both process and technology. Continuing professional education for the research participants was contextual to their project teams, the technology orientation of the project, and the individual's role within the team.

Self-directed learning activities followed the Update Model of continuing professional education (Nowlen, 1988), revolutionized by the innovative use of the Internet and the reliance on the significant peer. Experiential, or trial and error, learning is a key mode of inquiry for these professionals. They refer to this process as 'Load and Learn'. The sharing of knowledge, either informally or more formally through presentations and demonstrations, is also a component of the SQA professionals' learning activities within this organization. As well, some participants reported that they reinforced their learning through teaching others. There is a collectivist orientation to their support of each other in meeting new learning needs, and this spans from process (test plans, test reports, agile test methods) to technology (new operating system and database features).

This model replaces the classroom-based learning orientation of traditional continuing professional education conducted by organized bodies. It is far more learner-centered with an emphasis on technical learning. There is a mix of team-based and self-directed learning experienced by the software quality professionals in the organization. Team-based learning tends to focus on process-related knowledge while self-directed learning is used mainly for new technology and software applications. Team-based learning was reported to be the most pleasurable learning experience by participants.

Self-directed learning is augmented by access to significant peers who hold domain

knowledge or have prior experience with the technologies.

Participants report a high level of comfort with experiential and autonomous

learning, and their learning is driven by project requirements. Self-directed learning was

perceived by the participants to be an important vehicle for meeting their continuing

professional educational needs, especially related to acquiring new skills with

technology. The timeliness of availability, the pace of classroom instruction, complicated

by ESL (English as a second language) issues, makes such group learning experiences

less valuable from a content standpoint however classes were valued for the opportunity

to share the learning experience with others as well as a means to obtain reference

materials. Books, manuals and journals are not reported as key learning resources for the

software quality professionals in this organization; books and manuals are predominantly

used for reference purposes, especially for programming syntax clarification. Journals are

used for more recreational purposes.

Emphasis on Internet as Learning Vehicle

The Internet provides a contemporary method for self-directed learning as

participants move from one search reference to another to enhance their knowledge and

trouble-shoot problems in completing assigned tasking. Focus group participants

expressed a concern about lacking the time for in-depth research or learning; time

constraints in their project schedules enabled them to only learn enough to successfully

complete the tasking but not to master a subject area.

There is a gap in the literature with respect to the roles played by the significant peer and the Internet in the germination of the gold-collar worker in the technology organization. No prior research was identified by the principal investigator that described the central role of the Internet in contemporary self-directed learning activities in the technology field.

Learner-Centered Objectives

Participant learning objectives were often established as a result of project needs and documented through the annual appraisal process with management. For the most part, the software quality professionals in the organization charted their individual journeys of continuous learning (Flagello, 1998), and they relied heavily on self-directed learning on their own time to meet their learning needs. The organization does not meet the criteria for a learning organization as defined by Senge (1999) due to the lack of project-team learning activities and management engagement in providing for learning opportunities or direction. However, few organizations meet all of Senge's criteria for a learning organization. Team-based learning activities were centered on learning new processes or techniques essential to the software quality professional, detached from the project team affiliations.

The learning objectives reported by focus group participants as well as those reflected in the review of annual appraisals indicated that learning objectives were predominantly established by the software quality professional. There were several examples of learning objectives established by management that cut across teams of professionals, yet there were no examples of management-identified team-based solutions

for achieving the objectives. Software quality professionals are effective at establishing learner-centered objectives suited to the context of their projects and the technology that is being deployed. Greater formality in workplace processes to identify self-directed learning objectives and resources, create self-directed learning contracts, and recognize the importance of continuing professional education in the workplace is required of management,

The Significant Peer(s)

The role of the significant peer as a critical enabler of successful self-directed learning activities in is not accounted for in the literature on continuing professional education. This organization's self-directed learning activities are complemented by the significant peer as a means to move beyond blocking issues in learning or problem resolution. The participants in the focus groups reported a critical reliance on the significant peer for domain expertise, and occasionally those with specific domain expertise (e.g., C#) would initiate team-based learning activities with their software quality peers. Team-based learning was valued for the ability to learn from others' experiences and the pleasure of interacting with others. Software quality participants reflected on the reinforcement of learning through teaching others and/or applying new learning. The application of new learning was believed to trigger new learning experiences, according to one participant.

How do we legitimize and recognize the central role of the significant peer in the technology workplace? Does employee reliance on the significant peer undermine the authority or esteem of the project manager? Are adaptations to existing management

models required to enable open access to significant peers? There are many questions to be answered as we elevate the importance of peers with domain expertise within the workplace. The role of the significant peer is currently an informal part of the workplace learning culture, yet it is critical to sustaining continuing professional education for the software quality professionals. In this organization, several significant peers were given the title of 'software architect' based on their domain expertise. They serve as consultants to the project teams, performing research and coaching employees through technology shifts. The software architects achieve results through their influence rather than through authority. Such roles are very important to cross-functional teams led by project managers do not excel as technologists. Is it appropriate to think that a leader must excel equally at management technique and the depth and breadth of technology required to build new software products? Perhaps a great project manager knows how to collaborate with key 'significant peers' to achieve the best results – timely products that are fit for use by customers.

Impact of Organizational Culture

Resources were available within the organization for self-directed learning however participants reported difficulty allocating time for learning in the workplace. They also reported difficulty attending scheduled classes due to workload demands and a lack of support from some managers. The organizational culture did reflect strong peer support for individual learning needs, especially for problem resolution. According to Senge, "The more productive that workplaces become, and the more they embody organizational learning, the more problems they seem to create for people. In particular,

the increased involvement demanded by organizational change, and by the "learning organization," (1999, p. 96) seems to require more time and energy from employees than they can easily provide—especially given the increasingly complicated pressures of their private lives. A large number of participants identified the need to learn on one's personal time as problematic and a barrier to learning. Senge goes on to explain that his research showed that success at home and at work can reinforce each other – "They only seem opposed because it takes such excessive effort to maintain them in isolation from each other. When business agendas clash with personal agendas, people assume that their personal needs must give in" (1999, p. 96). Workplace cultures that emphasize face time rather than productivity, and fail to provide flexibility, do not achieve the performance levels desired. "Our research also suggests that the attitudes about face time and headcount are often not based on the actual needs of the business: they're based on stereotyped, habitual organizational expectations" (Senge, 1999, p. 97). The project managers in this organization are largely untrained in management practices due to a lack of company-provided management training opportunities and a company culture that values technical skill over managerial skill. A lack of skill in empowering others can result in authoritative methods that are incompatible with workplace flexibility and self-directed learning, whether on or off the job.

The questions: 'What support systems are needed for self-directed learning by the participants?' and 'What are the barriers or enablers to self-directed learning in the organization?' had some overlap in participant responses. The most significant resource shortfall within the support system or culture of the organization is time for learning. The data suggests that the software quality professionals must often learn new technologies in

their personal time, despite their stated preference for allocating learning time within their agile project team tasking. Management pressure to meet project schedules was cited as a barrier to attendance at scheduled classes or study groups. The data reflect a need for management policies that address the role of manager as educator or facilitator of learning for project teams and prioritization of some amount of time for self-directed or team learning. In comparison to other professions such as accounting or nursing, software quality assurance professionals face greater turbulence in terms of changing technology yet no formal (by management or professional organization) acknowledgement of the continuing professional educational investment required to maintain continuing competence. Professionalization of the field through future licensing or certification requirements may provide the public endorsement of the ongoing CPE investment required of the role. Conversely, such professionalization may also constrain the definition of learner needs in the technology realm. The learning needs are often specialized and unique to the position, such as performance testing, database administration, or test automation. Timeliness of learning materials for new operating systems was reported as a barrier by participants; this barrier was addressed through the innovative use of the Internet for conducting customized searches as the operating systems evolved (from beta to post-release vendor documentation).

Co-location of project team members is considered by the participants to be an enabler of learning, where learning is focused on achieving product release. Many technology organizations emphasize co-location in their facilities and organizational planning. Smith (2005) identified co-location of agile teams as one of the strengths of agile software development. There are opportunities for management to consider team

co-location as part of organizational learning strategy due to the benefits cited by participants. From a project team perspective, there is also an opportunity to reflect on the potential disadvantages of global or outsourced software development and test tasking.

Apart from software vendor certification programs and the few participants enrolled in degree programs, there were no development objectives for the participants driven by organized and ongoing professional learning programs. Continuing professional education for the participants was predominantly focused on expanding knowledge and skill in specific areas of technology such as C# programming and new Exchange or SQL database releases. Such CPE activities also appeared to provide participants with an opportunity to define their domain expertise and value to the organization, despite the time constraints and the difficulty in studying to the point of achieving subject matter mastery.

Future Research Opportunities

An area for future research could center on the role of critical self-reflection or reflection-in-action in the establishment of software quality professionals' learning or development objectives. Again, when this role is compared to other professions, the definition of continuing professional education objectives over time is vague. Certain technology trends such as shifts to the C# programming language or operating system virtualization help to refine objectives for specific software quality professional roles. Study of the role of critical self-reflection in establishing learning objectives could enhance our understanding of how software quality professionals identify and plan their learning activities.

Further investigation of the value of computer programming and logic knowledge to the software quality professional could also be beneficial to understanding baseline skill requirements for the roles and future team-based learning programs. Participants across the focus groups indicated that programming and logic knowledge was essential to success in their roles.

Potential future action research projects might focus on co-location and organizational culture. Improved co-location strategies with additional emphasis on needed resources (conference rooms for team meetings, white boards, flip charts, reference manuals, etc.) could be similarly studied. The implementation of programs such as that used by Google to allow time on the job for learning and creative thinking provide the opportunity to study employee satisfaction and productivity. A job rotation program enabling software quality professionals to spend time in customer support roles might also provide an interesting opportunity to study the benefits of learning through problem resolution.

Additional study of the management styles most effective in leading the gold-collar workers in technology fields will provide insight into the ways in which management can maximize authorship and productivity. Management has a key role in determining the culture of an organization. The workplace cultures for technology workers must embrace the use of the Internet for problem solving and research, provide time to self-directed learning, and support active collaboration among peers. Traditional management command-and-control methods to reach business objectives are not appropriate for gold-collar workers. New policies and programs to support continuing professional education in the workplace are required.

Finally, mentoring as a means to provide a 'significant peer' to new-hires or employees undertaking autodidactic leaps in learning could also provide a valuable future action research project. Mentoring can provide a means for competent learners to move to greater levels of proficiency. Mentoring can also enable those facing difficulties with English as a second language or cultural barriers with the encouragement needed to undertake more inclusive roles within the organization.

Summary

Senge suggested that "the practice of organizational learning involves developing tangible activities: new governing ideas, innovations in infrastructure, and new management methods and tools for changing the way people conduct their work. Given the opportunity to take part in these new activities, people will develop an enduring capability for change. The process will pay back the organization with far greater levels of diversity, commitment, innovation, and talent" (1999, p. 33). This case study research activity provides insight into numerous ways in which those who lead software quality professionals can embrace policy changes to support self-directed and team learning to better enable continuing professional education in the workplace. Potential policy considerations include cultural aspects such as co-location of project teams, flexible work hours, mentoring programs, and time for self-directed and team learning activities integrated into project schedules. Additional policy considerations should be focused on funding for continuing professional education activities such as subscriptions for indexing search engines on technology subjects, Internet access, cloud computing resources, and computers for home-based learning and tasking. As more people are

pushed to perform self-directed learning and project tasking from home, their needs for

adequate hardware (CPU performance and memory, in particular) increase. The

deployment of policies and resources that support and enhance self-directed and team

learning in the workplace will act as enablers to continuing professional education for

software quality professionals. Management that embraces the role of learning facilitator

and advocate for individuals and teams will provide the cultural support needed to create

a truly learning organization and provide a workplace context in which employees can

thrive and succeed in meeting learning objectives that satisfy both corporate and personal

goals. This research activity has verified that cultural support systems and resources are

important to the achievement of self-directed learning activities.

The software quality professionals participating in this research activity provided

new information pointing to an innovative model of continuing professional education.

This model is driven from self-directed learning through just-in-time Internet searches

and consultation with the significant peer. This model enables the software quality

professional to address ongoing changes in the technological and process landscape of

software development. As one employee recently noted, "You're only as good as you

Google."

Key messages for leaders of software quality professionals are derived from this

research study and complemented with my experience within the profession. There are

important priorities for managers and project leaders overseeing the work of software

quality professionals. To maximize the effectiveness of the organization and the resulting

high level of desired product quality, leaders and managers must foster new

organizational values.

First, recognize that it is unlikely that the continuing professional education needs of your employees are being met through external professional organizations or traditional CPE methods. Your gold-collar technology workers have different learning needs and styles than the agrarian, industrial or manufacturing workers of past eras. The diversity of your employees requires greater understanding of the cultural and language issues involved with their continuing professional education. Carefully consider the impact of the use of global or outsourced development or test resources from the standpoint of barriers and enablers of team learning.

There is a need for flexible methods to meet the pace of the continuing professional education requirements in the software profession. Serve as facilitators of adult learning in the workplace with more formal policies and programs to support learning. Thoughtfully consider learning programs in annual business planning processes. Prioritize time and resources for individuals and teams to engage in workplace learning activities, including self-directed learning. As well, co-locate project teams to enhance the learning environment.

Provide recognition and rewards for your gold-collar workers. Embrace the cultural workplace shift to increasing self-directed learning, use of the Internet, and access to significant peers to investigate and solve problems. This requires greater authorship for employees. Provide opportunities for employee contact with customers; this is an important learning vehicle for software quality professionals. Share organizational influence and power beyond titled management roles with those members who act as significant peers. Significant peers make a critical investment of time and effort in the continuing professional education of themselves and those around them.

Change your thinking about the atypical image of the productive software quality professional to include the dynamic nature of their learning interactions with others in the workplace. It is quite possible that the more lively the workplace in terms of interaction and dialogue, the more productive the efforts of the employees. A silent workplace environment may imply a lack of learning and problem solving rather than industriousness.

There are great opportunities to improve the quality of software products when organizational leaders recognize the critical role employers play in meeting the continuing professional educational needs of employees. Companies deploy unique processes and technologies to create today's software products. Employees have developed a unique learning model through the use of new technology. Formalizing a strategic goal to nurture and sustain a learning organization is a critical next step for leaders, managers, and project managers in the software industry.

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Appendix A: IRB Narrative - Modified

Section 1:

1. Continuing Professional Education for Software Quality Assurance

2. Purpose of the study: This study seeks to understand how self-directed learning is used in a software quality assurance organization to meet continuing professional education needs.

3. Rationale: I have found no related research in the field of continuing professional education (CPE) for software quality assurance professionals. Given the lack of higher education programs in software quality assurance, the demand for robust and reliable software products, and the constant improvements and changes in technology and associated tools, this study seeks knowledge of how self-directed learning and team-based learning contributes to continuing professional education in an SQA organization. Continuous improvement of SQA skills and process knowledge is essential to achieving the goal of producing software products that meet or exceed customer expectations. The study seeks to learn about current self-directed and team-based learning for SQA professionals in an organization, how learning objectives are established, and barriers/enablers for self-directed learning.

Section 2:

1. Number of subjects: This will be an exploratory case study of an organization comprised of approximately 37 software quality assurance employees at Double-Take Software, Inc.

2. The subject population consists of men and women predominantly from the U.S.; Romania, Nigeria and Indonesia are also represented in the subject population.

3. Inclusion/exclusion criteria: Inclusion criteria for the team interviews are SQA professionals working at Double-Take Software, Inc. This is a group of approximately 37 full-time employees. Exclusion criteria are any SQA professionals working on contract to Double-Take Software, Inc. outside of the Indianapolis office.

Section 3:

1. The participants are identified by me, the executive director of the organization.

2. The text of the email interview invitation to solicit participation follows:

    Dear XXXXX:

    I'm in the dissertation phase of my doctorate in adult education at Ball State University.

    I'm doing research on how software quality assurance professionals at Double-Take Software, Inc. learn about new processes and technologies to meet their job requirements.

I'm writing to invite you to participate in a 1.5 hour team-based focus group session. Your participation is optional.

Focus group sessions will be digitally recorded and transcribed. All data will be maintained confidentially and no identifying information will appear in any publication or presentation of the data. All data will be secured by me.

Please feel free to email me or call my cell (below) if you have any questions.

Many thanks for your consideration and assistance!

Sincerely,

Becky Hammons

Section 4:

1. This is a single, exploratory case study of an organization. The informants will be interviewed in focus groups of 3 to 5, based on their current project assignments.

2. Focus group sessions are to be 1.5 hours in length and will focus on three areas: (1) self-directed and team-based learning for SQA professionals; (2) barriers and enablers to self-directed learning; and (3) how learning objectives are established.

3. The focus group sessions with the SQA professionals will be conducted in person at the Double-Take Software, Inc. offices in Indianapolis. I will request the opportunity to follow up with additional questions, as needed for clarification purposes only. There are ten SQA teams targeted for focus groups.

4. Interview questions: (Note that these questions have been reviewed by Dr. Dolores Zage and Dr. Norman Wilde.)

    1. Give an example of a recent team-based learning activity.

2. Give an example of a recent learning activity you undertook as an individual.

3. Have you used CBT Nuggets this year? [Note: This is a web-based self-directed learning program focused on technology. We hold floating licenses for this program.] What is your choice for a learning activity? If not, why?

4. What type of books or journals have you read recently?

5. What blogs do you read regularly? Do you author a blog?

6. What resources are important to meeting your learning objectives? Do you have internet access at home? Is cost or availability of resources an issue for you?

7. How do you teach yourselves new technology such as Windows Server 2008 or server virtualization?

8. Describe one of your development objectives for 2008.

9. How does the team or organizational culture support or inhibit self-directed learning?

10. What was your most pleasurable learning experience this year?

11. What approach to software testing yields the most significant defects, in your experience?

Section 5:

1. The focus groups will be digitally recorded, archived on CD, and subsequently transcribed. I will take notes during the sessions. The data (focus group recordings, transcripts, and notes) will be retained in a locked filing cabinet for three years.

2.   Informants will be informed that the focus group data will be retained in a locked filing cabinet for three years on CD and then securely destroyed.

3.   Focus groups will be identified in any publication or presentation of the data by a number (1 through 10) and informants will be identified by an alphabetical letter (A through E) to provide confidentiality to the participants.

Section 6:

1. Potential risks and discomforts: There is minimal risk to the participants during the team-based interview process.

2. There are no physical or psychological risks to survey participants or interviewees.

3. The potential benefit to the participants and the SQA profession is the opportunity to identify key areas for future, local SQA continuing professional education tools.

Section 7:

1. There are no incentives being provided to participants.

Section 8:

1. There are no financial expenses to be incurred by participants.

2. There is no risk of physical injury during the research activity.

Section 9:

1. Informed consent: Informed consent will be requested via the focus group invitation request. Participants will be given the opportunity to "opt out" of the focus groups by declining the invitation.