2013

The role of a facilitated online workspace component of a community of practice: knowledge building and value creation for NASA

Bradford Thomas Davey

Pepperdine University

Graduate School of Education and Psychology

THE ROLE OF A FACILITATED ONLINE WORKSPACE COMPONENT OF A COMMUNITY OF PRACTICE: KNOWLEDGE BUILDING AND VALUE CREATION FOR NASA

Dissertation submitted in partial satisfaction

of the requirements for the degree of

Doctor of Education in Learning Technology and Leadership

by

Bradford Thomas Davey

July, 2013

Margaret Riel, Ph.D. – Dissertation Chair

This dissertation is written by

Bradford Thomas Davey

Under the guidance of a Faculty Committee and approval by its members, has been submitted to and accepted by the Graduate Faculty in partial fulfillment of the requirements for the degree of

DOCTOR OF EDUCATION

Doctoral Committee:

Margaret Riel, Ph.D., Chairperson

Paul Sparks, Ph.D.

Etienne Wenger, Ph. D.

TABLE OF CONTENTS

Page

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

ACKNOWLEDGEMENTS

I would like to thank Margaret Riel for her resolute dedication in helping me complete this work and her mentoring throughout this time. I am also indebted to my committee members, Dr. Paul Sparks and Dr. Etienne Wenger, who both provided invaluable feedback and encouragement throughout this process. It is true that we only stand as high as we do because it is on the shoulders of those who came before.

While having developed a considerable mastery of the English language through this process, I find it difficult to put into words the gratitude I have for my wife, Hilarie Davis. Hilarie, I thank you from the bottom of my heart for you tireless support and boundless love. I truly share this accomplishment with you.

VITA

Bradford Thomas Davey

Education

2012	Pepperdine University, Malibu, CA: Ed.D. Educational Technology and Leadership
2007	Pepperdine University, Malibu, CA: M.A. Educational Technology, summa cum laude
2004	Schenectady County Community College, Schenectady, NY: American Sign Language I and II, Certified
1993	Hartwick College, Oneonta, NY: BA Biology, BS Chemistry, Minor Environmental Science

Current Position – Senior Researcher

Technology For Learning Consortium, Inc. RI 2004-present

- Senior Researcher

Current Responsibilities

- Evaluation design
- Statistical analysis
- Survey development and analysis
- Online community development
- Report generation
- Digital video documentation: recording, editing and production

Professional Experience

Evaluation

Research Associate: Project Lead: Teachers on the Estuary (TOTE) program development and evaluation. Survey, interview, and review teacher work as part of ongoing professional development program funded through NOAA

Research Associate: Project Lead: NASA INSPIRE program development and evaluation. Survey generation and implementation, data analysis and presentation, supporting literature research, web tool training and development team participant.

Research Associate: Elementary and Secondary NASA Education program wide evaluation restructuring. Report generation, data analysis and presentation, and supporting literature research.

Research Associate: Project CITI, Technology Innovation Challenge Grant to improve literacy and achievement in K-5 students in New London, CT from USDOE. Conduct

data collection, entry, and analysis. Assist with report generation as part of comprehensive 5-year evaluation.

Research Associate: Project AMBIENT, data collection, entry, and analysis along with survey development and revision, item analysis. Videography, digital video editing and video production for 33 high schools in Dade County through the Rosenthal School of Marine Sciences at the University of Miami, funded by NIEHS.

Research Associate: NASA Explorer Schools, data collection, entry, and analysis of workshops. Assist with report generation as part of regular reports to funder.

Research Associate: Project Sun-Earth Day, on-site data collection, survey development, data entry and analysis. Assist with report generation for this NASA sponsored program to bring solar eclipse information and viewing to participants around the world.

Research Associate: Project Tri-State History Consortium, data entry and analysis, phone interviews, and assist in report generation for the Teaching American History project of the USDOE.

Research Associate: Project SEE: Senior Environmental Experiences, survey development, data entry and analysis, assist with report generation, videography, digital video editing and production for Ramapo College and the Meadowlands Environmental Center in NJ.

Research Associate: Project Youth Ethics Initiative, digital video editing and production for annual conference. Data analysis and reporting on the effect of interactive instructional methods in professional development on teachers in cooperation with the University of Miami Ethics Programs.

Research
Albany Medical Center and Wadsworth Research Center
1994–1997 Research Scientist

- Conducted a thorough examination of the possible method of action of the NSAID Methotrexate.
- Interviewed and screened perspective study participants.
- Isolated blood components, assayed blood methotrexate levels, cultured cell lines, created novel flow cytommetry methods for amino acid level detection,
- Managed $500K budget
- Trained new technicians on laboratory practices and investigation protocol
- Wrote and presented research results for NSF, NAF, the Annual Conference on the Advancement of Arthritis Research

Hartwick College
1992 – 1993

- Researched the effects of interbrood parasitism with Dr. M. Murphy. Was responsible for tracking, banding, and releasing young birds.
- Created Davey method for assisting in the study of retinoic acid on limb bud development in chick embryos.

Teaching Experience

Brown School, Schenectady NY 1998- 2005

- Science Department Chairman, 2002-2005
- Science Teacher 7th and 8th grade – 2002 – 2005
- Upper School Advisor – 2001 – 2005
- Science Teacher 5th – 8th grade – 1998 – 2002
- Science Teacher Advisor for 4th Grade – 1998 – 2001
- Math Teacher 7th and 8th Grade – 1998 – 1999

Responsibilities

- Science Department Chairman – Developed and implemented 5th – 8th science curriculum. Coordinate budget and materials. Supervised science teachers and science instruction.
- Science Teacher – Created 8th grade science program which is designed to foster creativity, communication skills, scientific knowledge, cooperation, and leadership in 8th grade science students and prepare them for high school and the future demands of science exploration. Teach full course schedule to 7th and 8th grade students including laboratory experience.
- Outdoor Education Supervisor – Coordinate outdoor education curriculum to challenge students in novel settings and create new situations in which students must relay on one another to complete difficult tasks, e.g., three day trip to YMCA Camp Chingachgook of Lake George NY.
- Field Experience: Create and maintain cross-curricular activities and projects such as trips to Boston and Washington DC
- Technology use: Implement technology into daily classroom activities especially effective use of Internet resources, video production, music composition using Garage Band, digital microscopes and iMovie.
- Supervision: New staff supervision and mentoring including lesson reviews, peer review, reaching goals, and parental issues.
- Grant writing: Received the OEDSI grant for sustainability.
- Soccer coach: (2002 7 – 1, 2003 6 – 2, 2004 7 – 1)
- Ski Club chaperone
- Sign language teacher
- Percussion teacher
- Advisor to 7th and 8th grade. Work as liaison between students, teachers, administration, other students and parents. Developed curriculum and evaluation method and created student peer mentor program.

Brown School – ODESI documentary project, 2003 – 2005

- Initiated and implemented a pilot project on establishing sustainability projects within schools based on UN decade priority
- Organized student effort for completion of project goals.
- Primary contact for collaborations with other institutions.
- Film coordinator and executive producer for documentary footage
- Established student – student contact with outside institutions in Australia, and Vanuatu.
- Provided professional development for Brown School staff about sustainability education and importance

Publications

Davis, H, Davis, R.M., Davey, B. (2008). 4-H Science, Engineering and Technology: External Evaluation Report. Submitted June 26th, 2008.

Davis, H., and Davey, B. (2007). Pluto Isn't A Planet Anymore: How can teachers help students understand the ever-changing world? *Cable in the Classroom*, Jan 2007, pgs 12-13.

Davis, H., Cristini, A., and Davey, B. (2007). Environmental Education of Senior Citizens Through Inquiry and Videoconferencing. Submitted to *The Gerontologist*. Sep. 2007.

Davis, H. and Davey, B. (2007). Ethics for the 21st century: Examining the move from character education to ethical critical thinking through interactive instructional methods. University of Miami Center for Ethics.

Davis, H., Davey, B., Manzer, R., and Peterson, R (2006). *Digital Learning Network Evaluation Tool Development: Reduced Gravity Module*. Internal Evaluation prepared by Technology for Learning Consortium Inc. for Robert M. Starr, Program Manager.

Associations and Certifications

PDK – member 2007 - present

AERA member 2007 – present

NSTA member 2002 – present

ISTE member 2007 – present

Association for Supervision and Curriculum Development 2004 – present

Collation for Essential Schools (CES) – since 2004

Science Teachers Association of New York State (STANYS) – 2001 - 2005

STANYS Biology Point of Contact (BPoC) since 2003

Professional Presentations

NSTA – 2012 annual conference, Indianapolis, IN, "NASA's INSPIRE: Stories of success form the students themselves."

AERA – 2009 annual conference, San Diego, CA, "Action Research with Technology: Transforming Work Through Communication, Collaboration, and Community – Promoting the use of video literacy in the school"

NSTA – 2009 National conference, New Orleans, LA, “INSPIRE: Developing an online learning community with NASA”

NSTA – 2008 regional conference Portland, OR “Sustainability Education Through Utilization of Digital Video Production”

AERA – 2008 annual conference “Environmental Education of Senior Citizens Through Inquiry and Videoconferencing.”

ASCD – 2008 annual conference “It’s not magic, its science!”

NECC – 2008 annual conference “Problem Based Learning About Earth Systems Science in an Online Environment.”

ASCD – 2006 annual conference “It’s not magic, it’s science!”

NECC – 2006 annual conference, “Sustainability and Digital Video: A student generated multinational documentary program”

ABSTRACT

The purpose of this study was to examine the role of an online workspace component of a community in the work of a community of practice. Much has been studied revealing the importance of communities of practice to organizations, project success, and knowledge management and some of these same successes hold true for virtual communities of practice. Study participants were 75 Education and Public Outreach community members of NASA's Science Mission Directorate Earth Forum. In this mixed methods study, online workspace metrics were used to track participation and a survey completed by 21 members was used to quantify participation. For a more detailed analysis, 15 community members (5 highly active users, 5 average users, and 5 infrequent users) selected based on survey responses, were interviewed. Finally, survey data was gathered from 7 online facilitators to understand their role in the community. Data collected from these 21 community members and 5 facilitating members suggest that highly active users (logging into the workspace daily), were more likely to have transformative experiences, co-create knowledge, feel ownership of community knowledge, have extended opportunities for community exchange, and find new forms of evaluation. Average users shared some similar characteristics with both the highly active members and infrequent users, representing a group in transition as they become more engaged and active in the online workspace. Inactive users viewed the workspace as having little value, being difficult to navigate, being mainly for gaining basic information about events and community news, and as another demand on their time. Results show the online workspace component of the Earth Science Education and Outreach Forum is playing an important and emerging

role for this community by supporting knowledge building and knowledge sharing, and growing in value for those that utilizing it more frequently. The evidence suggests that with increased participation or "usage" comes increased value to the participant and the organization. This research illustrates the possible change in mindset held by participating community members when it comes to the nature of co-location. Additionally, it may be of particular importance in exploring changes in the community members' feelings of connection and belonging.

Chapter 1: The Problem

Statement of Problem

Organizations depend on the skills, knowledge, and abilities of each of their employees –this is the organization's human capital (Becker, 1993). Interactions between people within the organization have been labeled as social capitol, reflecting the interrelatedness of people who work together. To be more productive, organizations need to find ways to foster social capital from human capital (Becker, 1993). Communities of practice are organic and develop in settings that support both the organizations human capitol and help to foster social capitol. The question them becomes, "How can organizations support the growth and development of communities or practice and what are the benefits of doing so?" This study focuses on communities of practice and how an online environment facilitates communication and development of value for community members.

Problem Background

Community members have long interacted in what Lave and Wenger (1991) termed communities of practice. Communities of practice are groups of people who may work together, share a common interest, or face a similar challenge who, through extensive communication, develop a common sense of purpose and a desire to share related knowledge and experiences and ultimately improve their practice. These community members share what can be called a common domain and interact out of a need to better develop their shared understanding of challenges they face (Wenger, 1998a).

An entire generation is growing up in a technology rich environment enabling communication at unprecedented levels. As the "Net Generation" enters the

workforce, they bring with them their digital habits, expecting a certain level of technological integration to be part of their work environment (Tapscott, 1997). Simultaneously, businesses are utilizing technology to enhance their business operations including how they enable employee interactions and communication. The greater levels of communication have lead to increases in information sharing, interconnectedness of employees, and increased productivity (Tapscott, 1997).

Before the proliferation of the Internet, community members most often met face-to-face as geographically co-located groups (Lave & Wenger, 1991). More recently, groups of people sharing a common need to solve a challenge find themselves separated by great distances (Brown & Duguid, 2000). These distributed communities still benefit from interactions, the exchange of ideas and experiences, and the collective building of knowledge about their practice (Lima, Carvalho, & Ambrosio, 2007). Whether co-located or distributed, the focus of communities of practice are still the same. There is a need to characterize the role an online community space in the knowledge sharing and value creation of a co-located community of practice.

Tracing their roots to constructivism (Oliver & Herrington, 2000), anthropology and theories of practice (Wenger, Trayner, & DeLaat, 2011), communities of practice are guided by the interests of their members, controlling the community learning. Members can directly apply their acquired knowledge, which contributes to the knowledge building and also encourages continued participation. The learning that takes place occurs within the social arrangements of the activities themselves (Squire & Johnson, 2000) and relies on the participation of the members

(Bielaczyc & Collins, 1999). It is the purposeful interaction of members constructing meaning through active engagement that may translate to distributed environments (Brown & Duguid, 2001).

Distributed environments allow members sharing a common practice, desire to interact, and need to learn from others who are geographically removed to interact in the same ways as geographically co-located community members do (Boetcher, Duggan, & White, 2002). Distributed environments have also been shown to promote a sense of community (Mieszkowski, 2000) while maintaining our human need for social interaction (Rheingold, 1993). The number of organizations who have begun to press distributed communities of practice into service has grown (Glassop, 2002; Wenger, McDermott, & Snyder, 2002) allowing organizational members in distributed locations the opportunity to interact, collectively building their knowledge of practice.

Designing and Facilitating a Virtual Community of Practice

Throughout their life cycle, communities of practice continually rely on the social engagement of their members. As the community matures, going from an early comingling of peers struggling with similar issues to a vital engagement of members developing their practice, the types of interactions change to meet the needs of the community (Wenger, 1998b). This development of communities over time (Palloff & Pratt, 1999) is reflected in the community's changing language, practice, customs, and resources (Squire & Johnson, 2000).

Changes in a community are also reflected in the different types of member participation. As community members first begin to participate, they do so from the

periphery. As they grow in community stature and importance through the building of meaningful shared knowledge, they move to a more central role and in doing so, increase their influence on the community as well as new periphery members (Wenger, 1998b). As the community continues to mature, the types of interactions, what they represent, and their complexity change with them (Dube, Bourhis, & Jacob, 2006). Potentially, as the community becomes more geographically distributed, crosses more practice boundaries, becomes more permanent, and gains a greater heterogeneity through a diversity of cultures, it increases in complexity. While differences in complexity may present as a challenge to the community, sociability also changes to accommodate the changing needs of a more complex situation.

While a community may evolve in complexity over time, its members and their interactions remain the core. The structure of a community of practice is instrumental in allowing the community to grow, mature, and promote knowledge building among its members (Wenger et al., 2002) while maintaining the social interactions of the community. Actively structuring the community involves encouraging peer-to-peer interactions, increasing the number and frequency of member participation, focusing on learning and capacity building, and engaging members in sharing knowledge, developing expertise, and solving real-world problems (Serrat, 2008).

Ubiquitous technologies for the facilitation of communication and sociability have entered the workplace. Such technology has made possible the implementation of distributed communities of practice – also called virtual communities of practice (Brannigan, 2009) – that have been shown to be part of organizational success

(Rogers, 2000; Thomas, 2005a). Virtual communities have been shown to be successful when properly facilitated (Hildreth & Kimble, 2002), rooted in practice (Lueg, 2000), and promote strong social ties (Hildreth & Kimble, 2004). Like co-located communities, virtual communities of practice integrate the community and lend legitimacy, influence, and value to community members (Wenger et al., 2002).

Role of an Online Workspace in a Community of Practice

Throughout life, people join, participate, leave, and discover other communities as needs and interests change. With the expanding use of virtual environments, it has become increasingly common to communicate with distributed community members (Johnson, 2007). The ability to communicate and share knowledge with others has begun to revolutionize our ability to grown our own knowledge and the knowledge of our larger community. Both personally and professionally, we are just a few search words or clicks away from others members of our community 24 hours a day at the same time we are in contact with members of co-located communities of practice who may be members of the online component of the community as well.

Combining both the traditional co-located community with the emerging distributed virtual community may enhance practice (Johnson, 2001; Kimble, Hildreth, & Wright, 2001). By participating in a community with both an online component and a traditionally co-located component, participants take advantage of the technology tools for organizing information, interacting, co-creating and sharing with more community members more often. Leveraging technology in this way, organizations may be able to offer their members a broader community to interact

with, share ideas and experiences, and grow their knowledge of their practice together.

Purpose Statement

The purpose of this study to examine the role of an online workspace component of a community in the work of a community of practice. Much has been studied revealing the importance of communities of practice to organizations, project success, and knowledge management and some of these same successes have been shown to hold true for virtual communities of practice.

Research Questions

This study sought answers to the following research questions:

1. What is the role of the online workspace component in the Earth Science Forum Education and Public Outreach community of practice?
2. Does the online workspace support knowledge building within the community?
3. What value does the online workspace add to the organization and its members?

Context of the Study

The community of practice for this study was both the online workspace component and community of practice for NASA's Earth Science Mission Directorate Education (SMD) and Public Outreach (E/PO) community. In 2010 – 2011 the E/PO community was comprised of 72 professionals with a varied background from E/PO professionals to research scientists. The SMD Earth Science E/PO community has been meeting face-to-face annually and at other times of the

year when the opportunity arose such as at the American Geophysical Union and the National Science Teachers Association annual conference. At both the annual meeting and meetings of opportunity, the Earth Science E/PO community was trying to improve their practice through "share-a-thons," attending each other's presentations, poster sessions, invited speakers, having small group discussions, and organizing goal orientated break-out sessions.

In October 2010, an online community workspace was designed by members of the E/PO community of practice in conjunction with the facilitating organization with the goal of improving their productivity, sociability, quality of interactions, and knowledge building. Community members were introduced to the online workspace in webinars, asked to develop their profiles, and then encouraged to actively participate in the community by sharing resources, working on projects and using the resources that are available there.

This research is an analysis of the structure, facilitation, and interaction in the online community, and survey of community members, community designers and community leaders. A mixed method exploratory approach collected both quantitative and qualitative data through observation, analysis of the documents, postings and interactions in the online community, surveys and interviews of community members, and community leaders and sponsors.

Significance of the Study

This study is significant because it provides the research community concerned with communities of practice more information about the role of online tools to support the growth of communities. Online environments are rapidly

increasing in prevalence while much still needs to be understood about the value they add to their community and for the sponsoring organization.

Limitations of the Study

The study did not track member participation in the online environment in real-time so the researcher was unable to question community members during the course of their participation. Instead, data collected from community members, organization personnel, and the online community is collected form archives of interactions over a period of 15 months (October 2010 – January 2012). The study was also exploratory and while the findings are likely to be of value to Earth Forum E/PO community at NASA, it may be more difficult to generalize the findings to other communities.

Conclusion

The purpose of this study was to examine the role of an online community workspace component in the development of the work of a community of practice. This study was an ad-hoc analysis of the E/PO online community developed for the Earth Forum E/PO community of practice. Both quantitative and qualitative data was collected from the online environment, participating community members, and the sponsoring organization.

The results of this study may influence NASA's future sponsoring of online environments such as the one being studied as well as the importance of fostering collaboration and communication between distributed members of communities of practice in the development of better knowledge of their practice.

Chapter 2: Review of Relevant Literature

Introduction

The purpose of this study was to examine the role of an online workspace component and how participation in this workspace supports the work of an established community of practice. Although there have been studies that explore either virtual communities of practice or co-located communities of practice, this study examined the role of an online workspace component for a community of practice. Much has been studied revealing the importance of communities of practice to organizations, project success, and knowledge management (Wenger, 1998b; 2000; Wenger et al., 2002) and some of these same successes have been shown to hold true for virtual communities of practice (Dube et al., 2006; Hara & Hew, 2007; Wenger, White, & Smith, 2009). While the efficacy of virtual communities of practice is still being examined, whether online environments fostering communication and collaboration are rapidly becoming ubiquitous, is not in dispute.

This review of literature is divided into four sections:

1) Defining a Community of Practice

2) Structuring a Community of Practice

3) Interactions within A Community of Practice

4) Facilitating a Community of Practice

Each section situates an important area of communities of practice in the context of further study.

Part One: Defining a Community of Practice – Theory and Practice

In this section we review the literature defining communities of practice. We examine the development of the idea along with how and why it has evolved. We also

examine the extent to which this work on face-to-face (co-located) communities of practice applies to virtual (distributed) communities of practice. This helps support this study of a virtual workspace component developed to support an established co-located community of practice.

> Communities of Practice are important to the functioning of any organization, but they become crucial to those that recognize knowledge as a key asset ... Knowledge is created, shared, organized, revised, and passed on within and among these communities. (Wenger, 1998a, p. 5)

Lave and Wenger (1991) first proposed the concept of community of practice describing them as, "… a set of relations among persons, activity and world, over time and in relation with other tangential and overlapping communities of practice" (98). Much has been written about communities of practice, their effect on their members, impact on organizations, and usefulness in an increasingly virtual world. The interest in communities of practice continues to be high as organizations look to distributed communities of practice as vehicles to facilitate knowledge management in national and international business models. These geographically and temporally distributed organizations pose an important question: How do virtual practices facilitate knowledge-building and sense or community in a community of practice? What roles do the structure, facilitation, and interactions play in generating value for community members and the sponsoring organization?

People have thought and worked together for thousands of years (Hutchins, 1995) and it is commonly thought that language development coincided with community formation and cooperative behaviors (Deutscher, 2005). As humans

evolved, they built upon previous successes and began a cycle of iterative learning that led to cultural development and the eventual need for, and development of a language structure (Dowman, Kirby, & Griffiths, 2006). Language allowed for the communication of ideas and their adaptation to a particular task (Brett, 2002). With language, collaboration became mental as well as physical, so not only was the benefit "lighter work", but better results through joint problem solving.

Terkel (1975) found that when people worked together, they expanded their potential and can accomplish more than two people working alone. Thinking with others can result in more than the sum of the participants working alone due to the synergy created by joint effort (Terkel, 1975). While a group can offer great benefits it can also turn chaotic, offering little help or even hindering efforts if not tended appropriately (Kibble, Li, & Blanchflower, 2000). There needs to be some organization and facilitation of the group effort (Bostrom, Anson, & Clawson, 1993).

Many examples exist of the power and usefulness of communities of practice. One such example began in the early 1980s as researcher Julian Orr began to investigate the behaviors of the machine repair technicians – photocopy repairmen (Orr, 1996). What he found was that much of what they knew about the repair of the machines came not from their complex repair manuals but from the shared conversations and experiences of the repairmen themselves. Together, they shared a common problem – repairing the broken copy machines. When they went out on calls, they learned, developing individual expertise and mastery and then shared that knowledge with others (Brown & Duguid, 2001). Sharing and learning from others being faced with similar challenges made them more effective then they would have

been alone. They had spontaneously formed a community of practice around the requirements of their job (Orr, 1996).

When working with others, people can expand their potential and so quickly learn that two working together can accomplish more than two working alone and three can be better still (Terkel, 1975). Sharing a common language while working together allows people to coordinate efforts, align tasks, and increase our efficiency (Terkel, 1975) and as people work, they begin to share a common practice (Brown & Duguid, 2001), and a shared domain, or area of work (Lave & Wenger, 1991). Sharing a common domain and working together, people enter into a type of relationship typified as community (Wenger, 2002). The importance and power associated with establishing a community did not go unnoticed and in the 1960's as urban planners began to talk of community development (Katz, 1994), organizations began to see the power through the building of knowledge and utilization of information sharing (Krackhardt, 1990). By the 1980's the idea had caught the attention of Jean Lave and Etienne Wenger.

Together, Lave and Wenger (1991) developed a working definition of what they termed Community of Practice linking the two previously separate ideas of community and practice. They defined a community of practice as a group of people who may work together, share a common interest, or face a similar challenge who, through extensive communication, develop a common sense of purpose and a desire to share related knowledge and experiences as part of becoming a community of practice. Through their seminal work, Lave and Wenger argued that communities of practice exist everywhere and that we are likely a member of many different

communities simultaneously. In some of these communities we are core members with extensive experience and expertise, while in others we are marginal members on the periphery, listening and learning from others.

Developed from an examination of situated learning in social environments (Lave & Wenger, 1991), the concept of community of practice has continued to evolve. Wenger (1998b) moved the focus of communities of practice from novice-expert interactions towards individual participation where the individual's learning trajectory could take many shapes including never moving into full membership or mastery. In 2002, Wenger et al. explored communities of practice as managerial tools useful in improving organizational function and competitiveness. It is their work that is core to examining the nature and efficacy of knowledge-building, interactions and products in a community of practice.

Learning as knowledge building in a community of practice. Lave and Wenger (1991) proposed the new term of community of practice to incorporate the components of learning, meaning, practice, community, and identity, under a unifying social theory. Communities of practice have a historical connection to early ideas associated with constructivist theory (Knowles, Holton, & Swanson, 1998; Oliver & Herrington, 2000; Persichitte, 2000; Squire & Johnson, 2000) where control of learning shifts to the learners themselves and, in part, to social learning (Vygotsky, 1978). Knowles et al. (1998) found that using constructivist principles with adults helped to create a learning context where they were able to apply their previous knowledge and experiences to meaningful real-world situations. Adult learners have also been shown to construct meaning through various constructivist strategies such

as problem-based learning, structuring meaning from social activities, negotiated meaning, and building knowledge collaboratively (Coppola, 1999). Wenger (1998b) has described learning in communities of practice as situated in content and context. Wick (2000) defines the collaborative communities existing within communities of practice as those solving authentic problems. Situated and authentic learning in communities of practice are not codified or explicitly transferred, instead they take place in parallel, and in conjunction with the critical tasks and learning the operational activities of the community (Robey, Khoo, & Powers, 2000). Learning within a community of practice takes place within the social arrangements of the activities themselves (Squire & Johnson, 2000) and is, as such, participatory (Bielaczyc & Collins, 1999).

Communities of practice was coined as a result of Lave and Wenger's investigation of apprenticeships and their belief that the community itself was acting as a "living curriculum for the apprentice" (Wenger, 2006, p. 1) and identified the complex social relationship through which learning takes place and that was limited in the understanding and defining of professional communities and professional organizations. The refocusing on communities of learners with social theory looked to combine the characteristics of social interaction into a process of learning (Wenger, 1998a). Communities of practice also differ from project teams (McDermot, 2000) where membership is defined by the task and team members have specific roles to play during the life of the team. The project team typically has a finite goal and once the goal is met, the team is dissolved. Different still from project teams are learning communities (Riel & Polin, 2004) where the community is specifically designed to

support learning and may be one of three distinct types: (a) task-based, (b) practice-based, or (c) knowledge-based (Riel & Polin, 2004).

Communities of practice develop around shared understandings of what is important and grow out of the need to build knowledge related to the field (Wenger, 2002). Community members work together to construct and re-construct knowledge related to their practice (Bereiter, 2002). Wenger (2004) describes how groups work together directly, through meeting face-to-face and indirectly, through virtual meetings, and being brought together by the communities need to grow their knowledge and be part of a community of like-minded people. Through their interactions, Wenger found that they shared information, experiences, insight, and advice. Together they helped each other solve problems, had open discussions, and asked for help. Collectively, they develop tools and resources out of their common needs and as they grew their knowledge they increase their common bonds and came to recognize their interdependence. By focusing on things that matter to their members, communities of practice had a tendency towards self-organization and responded to external influences dynamically (Wenger, 1998b). Working together as a community, community members were able to accomplish more than when they were working alone (Wenger, 1998b).

Wenger (1998b) further outlined the theoretical basis for communities of practice, by describing them as evolutionary, forming out of necessity, and existing as part of, or outside of organizational structure. Liedka (1999) further expanded on the evolutionary nature of communities of practice describing them as member driven rather than organizationally formed and developing naturally over time (Squire &

Johnson, 2000). Wick (2000) focuses on the meaning of communities of practice for professional groups tasked with similar responsibilities. His work revealed the importance of allowing communities of practice to evolve to continue to meet the needs of the community members.

More recently, the traditional concept of communities of practice has been applied to a variety of groups with their home in online environments (Brown & Duguid, 2000; Mieszkowski, 2000; Nichani, 2000; Rheingold, 1993). Online communities are gathering places for members for the purposes of communicating with, connecting to, and getting to better know others online (Boetcher et al., 2002). While the medium may have changed and the tools for bringing people together are different, a sense of community can still be develop (Mieszkowski, 2000). Whether virtual or traditional, communities remain a vital component of the human need for social interaction (Rheingold, 1993) and offer places for learning, growning, and exploring (Shaffer & Anundsen, 1993). Organizations have reported an increased use of groups as part of their organizational plan for success (Glassop, 2002) and have cited them as a reason for increased successes with employee commitment and customer satisfaction (Overholt, 2004; Wisner & Feist, 2001). They have also found that decision-making is more effective when done collaboratively (Katzenbac & Smith, 1994). Supporting these group efforts with an online community has increased the community's effectiveness (Hoadley & Kilner, 2003).

Summary –defining a community of practice. Twenty years ago, Lave and Wenger (1991)introduced their ideas about communities of practice. Since then, communities of practice have been studied intensely (Brown & Duguid, 2001; Coppola, 1999;

Knowles et al., 1998; Squire & Johnson, 2000; Wenger, 1998b; Wenger, 2002; Wenger et al., 2002; Wick, 2000) and our understanding has evolved to include them as important tools in organizational structure (Wenger et al., 2002), used for knowledge management (Kimble & Hildreth, 2004), enhancing the sense of community (Wenger & Snyder, 2000), and enhancing collaboration (Kondratova & Goldfarb, 2004). Lave and Wenger (1991) effectively combined what was understood about communities and practice into a cohesive model of a shared common domain enhancing community members' ability to better their personal and collective practice. The concept of communities of practice relies on a belief that learning is both social and situated.

Communities of practice have developed around a shared understanding of what is important and have helped to build knowledge related to the field (Wenger, 2002). Through their interactions, community members have shared information, experiences, insight, and advice (Wenger, 2004). Together, community members constructed meaning through various constructivist strategies such as problem-based learning, structuring meaning from social activities, negotiated meaning, and building knowledge collaboratively (Coppola, 1999). As members interact, they developed a shared understanding derived from their social activities, negotiations, and knowledge building efforts. Such activities leave behind footprints of interaction that may be collected and studied to better understand the community's value.

More recently, the concept of communities of practice has been applied to a variety of groups with their home in online environments (Brown & Duguid, 2000; Nichani, 2000). Online communities are gathering places for members for the

purposes of communicating with, connecting to, and getting to know others online (Boetcher et al., 2002). Whether virtual or co-located, communities remain a vital component of our human need for social interaction (Rheingold, 1993) and offer places for us to learn, grown, and explore (Shaffer & Anundsen, 1993). Although the medium through which community members interact may be different, they still help promote a sense of community (Mieszkowski, 2000) for their members.

Part Two: Activities and Interaction within Communities of Practice

What important structural features of communities of practice are necessary for community formation and sustainability? This section examines the structures of communities of practice that have been observed and created. This provides a basis for examining the structures within a community of practice over time.

Workplace communities share common characteristics of how members work and grow professionally within them and have been documented extensively (Brown & Duguid, 2000; Lave & Wenger, 1991; Orr, 1996; Wenger, 1998b). Communities of practice are a normal and integral part of organizational life (Lesser & Storck, 2001) and at any given time, an organization is likely a combination of interrelated communities of practice with shared membership facilitating the sharing of knowledge and learning socially within the organization (Wenger, 1998a). Often, they develop and persist without the support or recognition of the organization, in essence, they are "self-organizing" (Nickols, 2003). Because of this, their sustainability is dependent on the emergence of community leadership and the continued voluntary participation of their members. While they persist naturally in many organizations, there has been an identified need to "actively and systematically"

(Wenger et al., 2002, p. 12) cultivate communities of practice for the benefit of the community and the organization, making them "sponsored" (Nickols, 2003). The assertion is that if communities of practice are beneficial for both their members and their organization (Wenger et al., 2002), they should be nurtured in the same way that a plant must be nurtured to reach its full potential. These organizational communities of practice share common characteristics. They are:

- Peer-to-peer collaborative networks
- Driven by the willing participation of their members
- Focused on learning and building capacity
- Engaged in sharing knowledge, developing expertise, and solving problems (Serrat, 2008, p. 1)

These common characteristics build upon each other to create an effective and sustainable community (Serrat, 2008). Taken as a guide to designing communities of practice together with earlier work on team development, a community of practice may be structured for success.

Research about communities of practice has revealed much about their structural components (Ardichivili, A., Maurer, M., Li, W., Wentling, T., & Stuedemann, R., 2006; Kerno & Mace, 2010; Putnam, 1996; Squire & Johnson, 2000; Wenger, 1998a; Wenger et al., 2002). The following five areas are described by Kerno and Mace (2010):

- Population size: Varies widely, from a few to hundreds. As populations grow, so does the likelihood of subdivision of the community or practice along related characteristics to optimize membership activity

- Longevity: A few years to several centuries
- Means of interaction: Frequently starts among individuals acquainted with one another professionally and who co-locate (facilitating regular interactions of core members). As new communication technologies allow for faster information exchange, richer media content, and seamless integration of geographically distant members, distributed communities of practice are rapidly becoming the standard not the exception
- Product vs. process: Communities of practice may be more natural with individuals having similar types of knowledge and background. However, communities of practice also contain members from different organizational specializations where people with different functional knowledge and responsibilities interact
- Intra vs. inter-organizational: A recurring problem often serves as a point of contact or node around which community of practice members within an organization coalesce. Communities of practice can also be a useful tool in inter-organizational settings by assisting individuals employed in fluid, rapidly changing industries. By allowing information exchange among affected organizations that individually might not have the time, resources, or manpower to remain current, employees are able to access a knowledge base of peers (p. 82)

These structural components outlined by Kerno and Mace (2010) along with others (Dube et al., 2006; Gilley and Kerno, 2010; Wenger, 2004) consistently described the size of the membership community, the length of time the community exists or needs

to exist, how members interact, the goal(s) of the community of practice, and whether the community of practice was self-organizing or sponsored (Nickols, 2003). An examination of these components revealed the nature of the structure of a community over time.

The start of a community of practice is a critical time. Taken collectively, Nickols' (2003) ideas provide a framework for community of practice start-up. He recommended a set of practices for framing a community: encouraging, not mandating participation, keeping things informal, supporting members' individual work, staying focused on learning from each other, sharing information in multiple ways. Once started, the design of the community became critical for community success.

Wenger (2000) has suggested that a self-designing community have six elements: (a) events, (b) leadership, (c) connectivity, (d) membership, (e) projects (in some communities), and (f) artifacts.

- *Events* are designed to develop a sense of identity for community members, around community needs, and offered in a timely manner.
- *Leadership* is central takes multiple forms to help guide community development. *Connectivity* focuses on relationships between and among community members facilitating the free exchange of ideas through multiple channels.
- *Membership* is kept in balance between achieving a critical mass and not exceeding the community's original focus while bringing peripheral members into central participation. *Learning projects* are actively participated in by

community members and are focused on filling gaps in community knowledge.

- *Artifacts* produced by the community reflect the important issues of their shared domain are critical and worthy of the energy to produce.

Taken together, these elements establish a community of practice that functioned to promote membership of appropriate members, while pushing their shared understanding and collective knowledge.

In order for a community of practice to mature and establish a level of sustainability, research has suggested focusing on the optimization of specific characteristics of the community including supporting member interactions, the sharing of knowledge, and helping to build a sense of belonging throughout the community (Li, et al. 2009). Li et al. (2009) further suggest that facilitating relationship-building among members promoted knowledge exchange that focussed on organizational management of the community. Ramaswamy, Storer, and Van Zeyl (2005) devised, implemented, and evaluated the effectiveness of a model designed to develop a sustainable community of practice in their organization. Their efforts yielded what they termed, "The 5-D Model" (Serratt, 2008, p. 83) that helps community members design communities of practice that are viable and sustainable.

The "5D" design model – Discover, Dream, Design, Document, Disseminate - (Serratt, 2008) offered five steps to designing and managing a sustainable community of practice while not completely representing the development of communities of practice. The model was based on similar ideas by Cooperrider and Srivastava (1987) and Ramaswamy et al. (2005) and has a theoretical basis in research from Abbott

(1996). “Discovering” involves exploring personal narratives for relationships to the community and so enabling new members to find shared purpose. “Dreaming” is necessary to collectively develop a vision for the newly forming community into the future. “Design” looks at developing the inner working of the community to promote knowledge sharing and innovation. “Document” attempts to reveal the extent of the participation of the community members and their learning. “Disseminate” looks to lend credibility and reveal value for the community to the sponsoring organization and help promote pride among the community members.

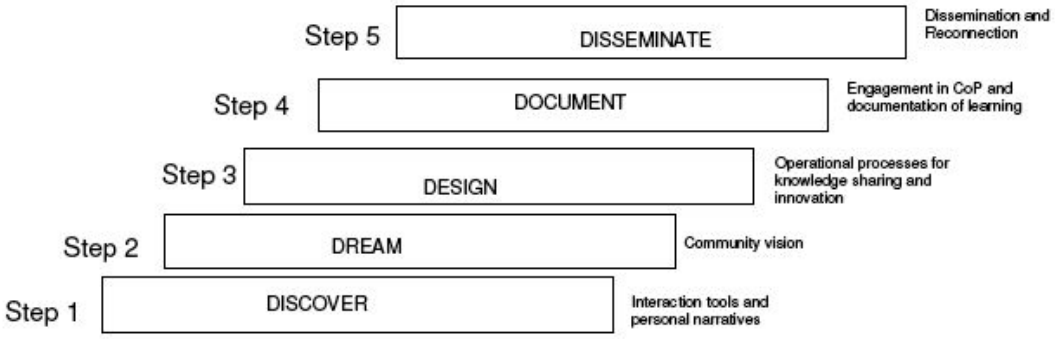

Figure 1. 5D Design Model (Ramaswamy et al., 2005, p. 83) – See Appendix A

Ramaswamy et al.’s (2005) model was to be completed during a three-day workshop. First, participants built relationships with other members through a variety of story telling activities designed to build a “web of stories that connect” (p. 84). Second, participants worked together to synthesize their stories around a joint purpose and mutually engaging direction. Third, participants created operational processes necessary to bring ideas into the physical world. The last two steps of the model build upon what has been previously explored regarding the importance of documenting and disseminating the work of the community to help lend importance and credibility

to what they do (Wenger et al., 2002). Wenger et al. (2002) do not offer these as distinctive steps in the model while they are present in many communities.

Palloff and Pratt (1999) have described the steps to developing a virtual community while tying their increased prevalence to increases in networked communication. Their suggestions are mirrored in later work by Rogers, Sharp, and Preece (2008) where the key elements of community design are defined purpose, easily navigated meeting space, rules of conduct, internal leadership, varying levels of participation, and facilitation. Taken together, these help establish a meaningful, purpose-driven, productive, interactive environment for the community members (Palloff & Pratt, 1999). Wenger et al. (2002) describe the stages of development a community of practice experiences as part of its normal life cycle. Haythornthwaite, Kazmer, Robins, and Shoemaker (2000) described community changes over time as initial bonding, early membership, and late membership. Communities of practice have also been described by their changing nature and how they relate to members' learning (Seufert, 2002). Thus, in both co-located communities and virtual communities, time plays a critical role in the development of both the community and individual members who together learn the language, practices, customs, and resources tying them together (Squire & Johnson, 2000).

Structure in distributed communities of practice. Stemke and Wilson (2009) offered a launch design template which focused on helping organizations develop and successfully launch a community of practice within their organization. They posed a series of questions that facilitate the organizational design of the community:

- What is the domain and why is it strategic?

- How will the community operate?
- What knowledge will it share and develop?
- What resources will it need?
- What will success look like?

These guiding questions, helped to align the newly forming community with the goals of the organization. Based in theory, they helped the organization determine the domain, practice, and products of the community.

In the design of virtual communities of practice including the development of the space, its tools, and artifacts, it is the formation of a commonly accepted domain that is essential to the formation of a functional community (Lave & Wenger, 1991; Wenger et al., 2002). This holds true for virtual communities of practice that are either designed (Allen, Kligyte, Boble, & Pursey, 2008; Baek & Barab, 2005; Krumsvik, 2005) or are emergent and self-forming (Murillo, 2008). Research also indicated that the transfer of knowledge is greater among people sharing a similar cultural experience within the community (Ardichvili et al., 2006; Bhagat, Kedia, Harveston, & Triandis, 2002).

Steps for developing a virtual community have been described by Palloff and Pratt (1999). Their first step is to clearly define a community purpose and create an appropriate meeting space for them. Secondly, leadership should be promoted from within the community to lend credibility and buy-in for members (Palloff & Pratt, 1999). They further suggested establishing member roles and defining a code of conduct. Additional considerations included first, developing a strong sense of community to enhance information flow, support learning, commitment of the group,

collaboration, and learning satisfaction and results in increased student achievement (Huffman & Hipp 2003; Williams, Atkinson, Cate, & O'Hair, 2008). Second, promoting knowledge and learning as central goals for the community of practice (Johnson, 2007). Third, understanding that organizational success is dependent on social learning within the organization, and acknowledging that the organization must take an active role in designing sociability (Wenger, 2000). Personal relationships are at the heart of any community of practice while virtual community environments can become impersonal with infrequent member contact or active facilitation (Squire & Johnson, 2000).

There are additional challenges faced when an organization chooses to initiate the community of practice. In a type of relationship Wenger (1998a) terms, "Legitimized" (p. 4), where the organization has officially recognized the community of practice as a value added component, there is a risk of over managing and over taxing the community of practice with new demands. Additionally, the organization may choose to strategically implement the community of practice as central to organizational or project success and in doing so, runs the risk of adding undue pressures for success of the community of practice (Wenger, 1998a). Johnson (2007) cautions the appropriation of communities of practice as tools for the promotion of learning and knowledge production for organizational development. His suggestions focused on both the process and products of the community and advised those studying communities of practice to have:

- A solid understanding of the historical social interactions
- Allow disagreement and differences as they are a key component of learning

- That learning and knowledge are a fluid process
- That members bring different personal and professional agendas that are reflected in their actions
- That social interactions are central to interactions supporting learning, knowledge, and practice within the community (Johnson, 2007).

Other challenges facing communities of practice have been discussed including online access for collaboration (Borthick & Jones, 2000), offering appropriate scaffolding (Fischer & Scharff, 2002), moving from teams to communities (Kerno & Mace, 2010), and keeping the communities focus on content, intention, contracting, and settlement (Seufert, 2002). These are useful in considering design features and member participation in community success.

All design decisions must be based on the value to both the individuals and the organization. First, time is the most often cited limiting factor in any profession. It is a common concern for communities of practice as well (Seufert, 2002). What time constraints do the potential community members currently face and how will membership in the community help relieve a time constraint they may have? Is the organization willing to offer time to their employees to participate in community activities? Second, how will the existing structure affect the community of practice? (Fischer & Scharff, 2002) How will the organizational hierarchy affect the interactions among members of the community of practice? Will the knowledge flow be hindered by position? Will the free exchange of ideas, critical to community success, be stifled by the historical pull of the organization? Third, how will the cultural environment be influenced by existing practice (Roberts, 2006). It is unlikely

that the newly formed community of practice will be able to resists the momentum associated with current sociocultural norms (Roberts, 2006). The stronger the social culture existing in the organization, particularly where valuing community is concerned, the greater the likelihood for this to carry over into the community of practice (Roberts, 2006). The structure of the community greatly contributes value to the members.

The other side of the value equation is for the organization. Value, along three parameters, is gained by the organization by investing the time and energy into a community's development and sustainability (Lesser & Storck, 2001). One value is enhanced organizational performance. Lesser and Storck (2001) revealed the direct organizational value of communities of practice and there effect on organizational performance. They identified first that, "communities of practice are linked to organizational performance through the dimensions of social capital" (Lesser & Storck, 2001, p. 833). Through this link they were able to identify four areas of organizational performance affected by communities of practice: (a) "Decrease learning curve"; (b) "Increase customer responsiveness"; (c) "Reduce rework and prevent reinvention"; and (d) "Increase innovation." A second value is the utilization of Communities of practice to examine emergent learning processes unique to the organization and taking place within the community (Wiessner, Hatcher, Chapman & Storberg-Walker, 2008). A third value offered, both to the organization and to the community members, is the recruitment and retention of employees by offering them social interactivity on a scale and scope greater then they would encounter on their own. Digital natives (Tapscott, 1997) entering the workforce expect this. All these

effects of a community of practice can be examined through self-report of its members and observations of organizational activities around the community of practice.

Comparing the structure of traditional and virtual communities of practice. The question has been raised about the efficacy of locating a community of practice in a virtual setting (Brown & Duguid, 2000; Palloff & Pratt, 1999; Wenger, 1998a). Kimble et al. (2001) contend that there has been no work to show, in theory, that communities of practice might not be able to exist in distributed environments. In 2001, Johnson surveyed existing virtual communities of practice, networked communities, learning groups, and individual experiences, concluding that communities of practice can exist virtually providing they have adequate technical and technology usage scaffolding to mitigate, "withdrawing, cultural differences, superficial discussion content, as well as lack of urgency in responding" (p. 56) which can weaken the development of the virtual community of practice. In 2006, Dube et al. studied the typology of virtual communities of practice revealing their differences and similarities and concluding that, "in order to ensure success, management decisions and actions have to be fine-tuned towards the unique personalities of their VCoPs" (p. 89).

The answer as to if communities of practice can exist virtually is not simply yes or no. Instead, they can be efficient and effective when located virtually so long as what Hildreth and Kimble (2002) call "soft knowledge" was shared effectively, that they were rooted in practice (Lueg, 2000), and strong social ties were established (Hildreth & Kimble, 2004). Additionally, there needs to be sufficient scaffolding in

place supporting the community and allowing it to thrive (Borthick & Jones, 2000; Seufert, 2002; Wenger, 1998a; Wenger et al., 2002; Wenger et al., 2009). The scaffolding necessary may take different forms ranging from implementation of the technology, skills specific to the virtual environment (Borthick & Jones, 2000), stated performance goals and conventions, knowledge of the utilized tools (Seufert, 2002), knowledge synthesizing tools (Winsor, 2001), technology stewarding (Wenger et al., 2009), and "…involving complex interactions between the local and the global" (Wenger, 1998a, p. 133) ultimately leading to personal ownership of the community of practice (Ramondt, 2008).

The web, "expands the possibilities for community and calls for new kinds of communities based on shared practice" (Wenger, 2006, p. 1) and Wenger et al. (2002) proposed that emergent communities of practice are being made possible by networked environments. Research by Kimble et al. (2001) determined that communities of practice could be maintained in distributed environments. Their findings suggest success in distributed communities of practice is dependent upon the development of strong relationships through the use of shared artifacts which is aligned with Wenger's (1998a) work in identifying structures that support participation as essential in community of practice development and sustainability. Internet communication technologies are playing an important role in increasing communication, participation, and collaboration among community members (Gannon-Leary & Fontainha, 2007) while being adopted in emergent areas of networked learning (White & Pagano, 2007). Applying the original concepts of communities of practice, various forms of virtual communities have been formed: (a)

Virtual Communities of Practice (Neus, 2001); (b) e-learning Communities of Practice (Kirkwood, 2006); (c) and Electronic Communities of Practice (Wasko & Faraj, 2000).

In traditional communities of practice, the members, such as midwives, were meeting face-to-face while living in the same community forming a co-located group. Together they learned from each other through direct contact with both the members of the community and the practice itself. They were tightly knit groups often encompassing small geographical areas (Lave & Wenger, 1991). Among these women, there was strong reciprocity keeping the community small and growing slowly. They were bound together by the direct flow of knowledge between them and depended on it greatly (Lave & Wenger, 1991).

While technology may be secondary to social and cultural aspects of communities of practice (Wenger, 2001), Lave and Wenger (1991) do not limit communities of practice to co-locatable, well-defined or identifiable groups. Rather, it is participation in, sharing of a common practice, and developing collective knowledge that defines and binds the group. This opening, not being tied to place and time, offers a unique opportunity for communities of practice to continue to play a critical role in the sharing of knowledge and practice between members in an ever-expanding world of virtual communications. While ubiquitous technologies have made commonplace virtual communities (Brannigan, 2009; Rogers, 2000; Thomas, 2005a; Wenjing, 2005).

Many studies of virtual communities of practice have been conducted (Dube et al., 2006; Teigland & Wasko, 2004; Wenger et al., 2002). Virtual communities of

practice, described by Wenger et al. (2002), take many forms. They have identified size, life span, geographical dispersion, boundary span, creation process, and degree of institutionalization as critical factors combining to produce different types of communities of practices. Dube et al. (2006) have identified what they term "structuring characteristics" (p. 71) that refer to the common elements of virtual communities of practice present throughout their life that may be used as a gauge to determine the communities basic identity, it's health and maturity. Teigland and Wasko (2004) have found computer-mediated communication as a sufficient medium for the "complex interactions necessary for the combination and exchange of knowledge between individuals, thus facilitating their ability to learn" (p. 239).

With its origins in situated learning and social learning theory, learning in communities of practice takes place through interactions of community members with each other and artifacts. Virtual communities of practice facilitate similar experience for members by engaging them with other like-minded people sharing a common interest through engagement in discussions, debates, reflections, and knowledge sharing outside of formal learning practices (Murillo, 2008; Rogers, 2000; Thomas, 2005b). Hildreth, Kimble, and Wright (1998) concluded from their study of a distributed international organization that communities of practice did exist and that they shared many characteristics with what Lave and Wenger (1991) first described. First, Hildreth et al. found that there was a need for one-to-one communication to facilitate learning while there was a greater need for one-to-many communication at a level greater than reported in earlier work. Second, that groups evolved to populate a distributed environment similar to what Brown and Duguid (2002) identified. Lastly,

they found that there was not a "best" medium to facilitate community of practice formation but rather that, "Each medium is a medium in its own right" (p. 284).

Summary – structure of a community of practice. The structure of a community of practice is instrumental in allowing the community to grow, mature, and to promote knowledge building among its members. Structures that foster sustainability have been identified including the emergence of community leadership, appropriate population size, community age, the frequency and types of interactions, functional knowledge members possess, and intra vs. inter-organizational community. While communities of practice persist naturally in many organizations, there has been an identified need to "actively and systematically" (Wenger et al., 2002, p. 12) cultivate communities of practice for the benefit of the community and the organization, making them "sponsored" (Nickols, 2003). Actively structuring the community involves encouraging peer-to-peer interactions, increasing the number and frequency of member participation, focusing on learning and capacity building, and engaging members in sharing knowledge, developing expertise, and solving real-world problems (Serrat, 2008).

Wenger (2000) suggests a structural design for a community of practice that includes events, leadership, connectivity, membership, projects, and artifacts. Metrics on all of these can be collected through direct observation of an online community environment and by surveying participating community members. Palloff and Pratt (1999) have described the steps to developing a virtual community. They suggest that the increased prevalence of online communities may be tied to increases in networked communications. Their suggestions are mirrored in later work of Rogers et al. (2008)

where the key elements of community design are defined as purpose, easily navigated meeting space, established rules of conduct, internal leadership, allowing varying levels of participation, and facilitation. Wenger's design template for launching an organizational community of practice lists critical questions about structure that need to be considered during the various phases of development and illustrates a series of questions that can guide a study of a developing community. These steps are also closely aligned with those proposed by Palloff and Pratt and can be summarized as determining domain, community operations, critical knowledge, available resources, and indicators of success (Wenger, 1998a).

When the organization chooses to strategically implement the community of practice as central to organizational or project success, it should be designed so that its structures do not add undo pressures for success by the community of practice (Wenger, 1998a). Structural components can also be used to mitigate constraints to community success such as participant time, organizational hierarchy, idea exchange, and the pre-existing cultural environment of the organization. Measuring enhancements from the community for the organization involves looking at the knowledge created as a result of community member participation as well as products used by community members and those offered as tools to the larger organizational community (Lesser & Storck, 2001). A measure of the tools generated and collecting community member stories of value from community participation may reveal the organizational value that has been created.

Kimble et al. (2001) determined that communities of practice could be maintained in distributed environments. Ubiquitous technologies have made virtual

communities of practice commonplace (Brannigan, 2009) with many different ones emerging (Rogers, 2000; Thomas, 2005b; Wenjing, 2005). Virtual communities of practice are effective when they are structured to facilitate the sharing of soft knowledge (Hildreth & Kimble, 2002), their activities are rooted in practice (Lueg, 2000), and they promote strong social ties (Hildreth & Kimble, 2004). There is also a need to have sufficient structural scaffolding in place that supports the community for it to thrive. The structural scaffolding necessary may take different forms ranging from implementation of the technology, the development of skills specific to the virtual environment (Borthick & Jones, 2000), clearly stated performance goals and conventions, the deelopment of knowledge of the utilized tools (Seufert, 2000) and the synthesizing tools (Winsor, 2001), and technology stewarding (Wenger et al., 2009). This review shows that a close analysis of these structural scaffolding efforts may reveal the role and success of the online community in the work of a community of practice.

Structural components of importance for study would include the community size over time, means of interaction between members and how they are supported by the community structure, how community members with differing backgrounds and responsibilities within the organization have been brought together, events, community leadership, community projects, and community artifacts produced. Each component of community structure potentially plays an important role in the activities and value of the community. Structural components may also inform our understanding of the evolution of the community temporally.

Part Three: Knowledge Building and Interactions within A Community of Practice

What interactions occur in a community of practice and what role do they play in member participation and knowledge development? In this section, we examination the different types of interactions occurring within a community of practice and may be considered areas of further study within the online community.

A community of practice has been described along three dimensions (Wenger, 1998a): (a) What it is about (joint enterprise); (b) How it functions (mutual engagement) and; (c) What capability it has produced (shared repertoire). "Joint enterprise" is the common enterprise that the members of the community share. This common enterprise is mutually recognized and continually renegotiated by the group members. "Mutual engagement" is how the community members interact and share information and experiences. "Shared repertoire" is the mutual resources developed over time and available for use and continued refinement by the other members of the community. The interactions can be examined within the domain, through different processes (interactions), and in the products that result from the interactions.

Stages of development have also been identified for communities of practice that provide insight into how content changes over time (Wenger, 1998a). The stages roughly correspond to the age of the community and what relationship it has with its members. By looking closely at a community of practice's development over time, a measure of growth may be established. The level of growth can also be related back to the efforts of the organization in purposefully nurturing the community of practice as part of their organizational goals (Wenger, 1998a; 2002; 2004). The growth and

development of a community of practice is organic and so not all groups follow the specific stages of development exactly (Cox, 2005). However, the stages of development provide scaffolding for characterizing the interactions in the community over time.

Wenger's (1998a) Stages of Development:

- Potential – Peers struggling with similar issues without identifying themselves as members of a group
- Coalescing – Members come together and recognize their potential for group interaction
- Active – Members are engaged in the development of their practice
- Dispersed – Members are less intensely engaged while continuing to be involved as part of a hub of knowledge for the community
- Memorable – While membership is no longer central to individual identity, people still identify themselves as members and recognize its importance in their success

Wenger's (1998a) stages of development illustrate a life cycle associated with the emerging community of practice. From first identifying members who share a common domain and face similar struggles, to being able to identify those members within the community of practice who hold much of the historical knowledge and traditions, there is a natural progression through which the community of practice moves toward greater knowledge-building and productivity as it matures (Wenger, 1998b).

Wenger's (1998a) stages also parallel what Palloff and Pratt (1999) described as the typical life cycle for community development: (a) forming, (b) norming, (c) storming, (d) performing, and (e) adjourning. At the outset, a community is "forming" and in doing so must test the waters during its infancy, looking at what the community needs are and what direction to take while members get to know more about each other. During its mid-life, a community faces issues around establishing norms and shared understandings, bridging boundaries, challenging beliefs, building knowledge, and developing artifacts of that learning. At the end of the life cycle of the community, formally or informally, upon reaching the extent of its usefulness, the community will dissolve or morph into a new community. When focusing on the specific development of a virtual community, Palloff and Pratt refer to delineated phases of community building. Consistent throughout these perspectives is the nature of community development over time (Haythornthwaite, et al., 2000) through language, practice, customs, and resources (Squire & Johnson, 2000).

These discussions of the stages of a community assume a stable membership. Communities of practice are fueled in part by new members. How do they engage with a community regardless of its stage? Central to Lave and Wenger's (1991) original idea of a community of practice was the concept of Legitimate Peripheral Participation (LPP) where newcomers to a community of practice engage in peripheral activities and slowly move towards participation in more central activities as they gain exposure to the community's language, ways of knowing, experts, and artifacts. The hypothesis is that through gradual advancement, members appropriate an identity increasingly similar to those central within the community. Brown and

Duguid (2000) coined the term Network of Practice describing the emerging relationship between individuals and geographically separated social networks. It is the participation of community members that was key to life of the community of practice (Lave & Wenger, 1991) where participation is inseparable from practice. Facilitating peripheral movement from within was a central role of the newly structured community of practice.

Knowledge and learning have been described as fundamental to the process of innovation and change and they have become increasingly pivotal in partnerships and other types of relationships dependent on interaction (Johnson, 2007). In these communities of practice, a continuum of member participation existed where newcomers learn from old-timers by interacting with them around their shared practice, benefitting both (Lave & Wenger, 1991). Investigations have shown that over time, these newcomers move from the periphery into a more central role within the community through legitimate participation in the building of meaningful shared knowledge (Wenger, 1998a).

Ten years after Lave and Wenger (1991), Wenger et al. (2002), described communities of practice in terms of groups of, "…people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (p. 4). This new description reflected changes in thinking about the nature and purpose of communities of practice (Contu & Willmott, 2000; Davenport & Hall, 2002; Vann & Bowker, 2001) towards an emerging managerial tool and as so, redirects the focus towards the value to an organization as well as the individual (Cox, 2005).

Part of what has emerged is how the nature of interactions change over time. A comprehensive study of 18 virtual communities of practice was undertaken by Dube et al. (2006). They developed a typology containing 21 structural characteristics and used their findings to illustrate the diversity prevalent among three of them.

Table 1

Structural Characteristics of a Community of Practice and their Complexity (Dube, et al., 2006)

Structural Characteristic	**Increasing Complexity →**	
Orientation	Operational	Strategic
Life Span	Temporary	Permanent
Age	Old	Young
Level of Maturity	Transformation Stage	Potential Stage
Creation Process	Spontaneous	Intentional
Boundary Crossing	Low	High
Environment	Facilitating	Obstructive
Organizational Slack	High	Low
Degree of Institutionalized Formation	Unrecognized	Institutionalized

(Continued)

Structural Characteristic	**Increasing Complexity →**
Leadership	Clearly Assigned → Continuously Negotiated
Size	Small → Large
Geographic Distribution	Low → High
Members' Selection Process	Closed → Open
Members' Enrollment	Voluntary → Compulsory
Members' Prior Community Experience	Extensive → None
Membership Stability	Stable → Fluid
Members' ICT Literacy	High → Low
Cultural Diversity	Homogeneous → Heterogeneous
Topic's Relevance to Members	High → Low
Degree of Reliance on ICT	Low → High
ICT Availability	High Variety → Low Variety

Taken individually, these characteristics provide specific and detailed information about the growth of the virtual community of practice, its complexity, and where it may be going developmentally while not defining a development path for the community of practice. Dube et al. (2006) have defined a continuum for many of the structural characteristics discussed by others. For example, as a community evolves through constructivist activities, it grows geographically, pulls in members without prior community experience, and develops greater diversity.

Social aspects of a community of practice. Working with others means working and learning in social settings. Social learning theory identifies the need in learning to observe and model the behaviors, attitudes, and emotions of others in order to avoid the difficulty and potential danger of learning in isolation (Bandura, 1977) states:

> Learning would be exceedingly laborious, not to mention hazardous, if people had to rely solely on the effects of their own actions to inform them what to do. Fortunately, most human behavior is learned observationally through modeling: from observing others one forms an idea of how new behaviors are performed, and on later occasions this coded information serves as a guide for action. (p. 22)

Learning through observation as described by Bandura (1977) necessitates attention, retention, rehearsal, and motivation. Social learning according to Bandura has commonalities with the work of both Vygotsky (social development theory) and Lave (situated learning) which both emphasize the critical role of learning from others.

Two ideas from Vygotsky (1978) rely on interactions between individuals in social settings. He first points out how social interactions play an important role in the development of cognition. Vygotsky states, “Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological)” (p. 57). A child’s first interactions do not take place in a vacuum. Rather, they rely on others to provide meaning to the earliest motions and gestures. Secondly, Vygotsky points out that a learner’s level of development

depends directly on social interaction allowing the full range of skills to develop with guidance and collaboration beyond what could be attained independently.

Similar to Vygotsky and Bandura, Lave (1988), argues that learning as it occurs naturally, combines the activity, context, and culture in which it occurs and in this way is situated. Activity, context, and culture influence the learning simultaneously. Combined, they help to create a complete understanding for the learner and produce an environment described as a community of practice (Lave & Wenger, 1991) where social collaborative interactions are the norm (Brown, Collins, & Duguid, 1989).

There authors suggest that we learn by doing while signaling that what we "do" matters. The role of community in shaping our actions is described as essential. Learning with others involves interacting with those who share common goals, ways of thinking and knowing, and ways of achieving those goals. Learning as part of a community of practice (Lave & Wenger, 1991), members share the community's knowledge, common understandings, practices, identity, and values (Shaffer, Squire, Halverson, & Gee, 2004). By learning to "be" while at the same time learning "about," community members gain both knowledge of the practice and knowledge of the behaviors of those central to the community (Brown & Adler, 2008).

Interactions between members within communities of practice have been widely studied (Ardichvili et al., 2006; Brown & Duguid, 2002; Putnam, 1996; Smith, 2007; Wasko & Faraj, 2000; Wenger, 1998a; 2000; Wenger et al., 2002). The importance of social structure has been underscored consistently (Lave & Wenger 1991; Palloff & Pratt, 1999; 2001). Much of the focus on this work is on the social

relationships that exist within and sustain communities of practice. A community of practice is not just the sum of the knowledge its members possess. A community of practice is sustained as a result of the relationships between members and their practice over a period of time (Lave & Wenger, 1991; Wenger, 1998a). Communities of practice develop around issues that are important to people (Wenger, 1998a) and these people gather to form communities. Members of these communities identify themselves through their community's focus and as they share common experiences, develop a common language, and create a collective history growing the relationship among members.

Wenger (1998a) describes three dimensions of practice – "mutual engagement, a joint enterprise, and a shared repertoire" (p. 73). Embedded in these are multiple aspects of sociability. Looking at the characteristics described by Wenger that indicate community of practice formation, a variety of social interaction-dependent items are apparent:

- Sustained mutual relationships – harmonious or conflictual
- Shared ways of engaging and doing things together
- Absence of introductory preambles, as if conversations and interactions were merely the continuation of an ongoing process
- Substantial overlap in participants' descriptions of who belongs
- Knowing what others know and what they can contribute to an enterprise
- Mutually defining identities
- Local lore, shared stories, inside jokes, knowing laughter
- Certain style recognized as displaying membership

- A shared discourse reflecting a certain perspective on the world (p. 125-6)

Taken together, these characteristics reveal the dynamic social nature present within a community of practice and are reflective of the broader social structures, institutions, and sociocultural characteristics of the situated environment (Roberts, 2006). Accordingly, communities with strong social relationships may develop more effective communities of practice (Roberts, 2006).

For Wenger (1998a) communities of practice are important places of negotiation, learning, meaning, and identity. Such activities require mutual engagement through relationships between people and it is these relationships, built through engagement in practice (Lave & Wenger, 1991; Wenger, 1998a), that play a significant role in the growth and sustainability of the community. Parker, Patton, Madden, and Sinclair (2010) found that, "Positive personal and professional connections among stakeholders were critical factors in the initiation and maintenance of [a] CoP" (p. 349).

Situated learning in the context of communities of practice is reliant on the social nature of knowledge generation. Lave and Wenger's (1991) ethnographic study of communities of practice revealed that a social structure is critical to community success. While studying the relationship of the evaluator in developing communities of practice, a connection was made that tied knowing and learning to relationships within communities of practice (Abma, 2007). The interaction of those learning in the dynamic environment of a community of practice further the ties that bind members in shared practice and experience (Wenger, 1998a). The members themselves, through their social interaction, develop their own understanding and ways of

knowing (Orr, 1996). Orr further points out the collaborative and social nature of the interactions of the technicians and reveals the necessity of cooperative interaction to develop a complex working understanding of their domain. In his study of photocopy machine technicians, it was through the sharing of stories and experience, that the technicians developed a greater sense of identity and became further embedded in the community. Through their membership in a community, members engage in meaningful social interactions developing their shared understanding.

These productive social interactions occurring between and among members of the community of practice play an important role in the community's success. Combining both their physical and intellectual efforts, members create what David Perkins (2003) calls, "organizational intelligence" (p. 4). Working together, the community develops a greater understanding of a topic, task, or process and in much greater depth than one might alone. Communities of Practice have taken the intelligence of people and given them a constructive environment where they can inform practical action (Perkins, 2003). In this way, the community of practice has become an effective organizational tool for identifying and addressing important problems in the workplace (Lesser & Storck, 2001).

Within some organizations, groups of people working together, sharing common interests, facing similar challenges, share a sense of common purpose and grow their knowledge collectively. Learning has been described as a social act growing from everyday experience. This situated learning can be supported by membership in a community of practice (Wenger et al., 2002). Brown and Duguid (2001) describe a relationship between communities of practice and learning where

learning within the community of practice is demand driven, social, and critical for identity formation. By definition and from research, communities of practice are social and productive for individuals and for the group in their intellectual efforts around their practice.

Members of a community come together because of shared need, goals and identity (Hung & Chen, 2001). Participation in the community of practice brings learners into a social context defined by the social practices and activities of the community (Brown et al., 1989). In stating that, "Practice is an effective teacher and community of practice an ideal learning environment" (Brown et al., (1989), p. 127), Brown and Duguid (2000) reveal social cognition as central to communities of practice and it is personal identity that is formed through social interactions. When fully realized, participation in a community of practice can become one's, "source of identity" (Wenger, 1998, p. 56).

Collaborative social networks – knowledge-building in a social environment. Community knowledge remains a key component of a community of practice (Gherardi & Nicolini, 2000) advancing the collective knowledge of the group while simultaneously increasing individual knowledge (Bielaczyc & Collins, 1999). In a community of practice, the knowledge developed collectively is greater than the sum of the possible individual knowledge. Wenger (1998a) described the production of learning artifacts and histories aiding in the transfer of knowledge between established and new members of the community and increasing their understanding. Knowledge is also developed through discussion of ideas revealing the importance of discussion between members (Bielaczyz & Collins, 1999). Brown and Duguid (2000)

suggest that problems are addressed and resolved through the social act of conversation.

Members of virtual communities who are willing to contribute knowledge to the virtual community see their efforts as part of a greater public good rather than that of the individual (Ardichvili, Page, & Wentling, 2003). When the community is put before the individual, it can become a moral imperative that often motivates individual sharing and contributing (McClure & Faraj, 2000). This sharing occurs because members feel a connection to either the organization as a whole or to their smaller community (Ardichvili et al., 2003). When sharing becomes part of the organizational culture pervasive within the virtual community, the power of the social network is apparent. Members of virtual communities also use their collaborative social networks as sources of new knowledge (Ardichvili et al., 2003). Some members equate the networks to encyclopedias, available when and how they need them, others perceive them more as a problem-solving tool where specific questions can be posted and discussed, while others perceive their community as a gateway to experts who may help them solve specific problems.

Summary – interactions in a community of practice. Interactions are the building blocks of a community of practice. Their nature and extent affect the value and sustainability of the community. Insight into the role of a virtual community of practice in the work of a group can be gained by looking at the nature of the interactions over time, the interactions of individuals as they move into the group, the stages of development of the community, the learning opportunities that occur, the knowledge building that occurs, and the sociability within the group.

Members interact differently as the community evolves through the stages of development. By looking closely at a community of practice's development over time, a measure of growth may be established. The level of growth can also be related back to the efforts of the organization in purposefully nurturing the community of practice as part of their organizational goals (Wenger, 1998a; 2002; 2004). Utilizing Wenger's (1998a) stages of development – (a) potential, (b) coalescing, (c) active, (d) dispersed, (e) memorable – we may be able to determine the developmental stage of the community at any given time. The changing nature of interactions within the community (Dube et al., 2006) presents itself as another potential area for studying the evolving community of practice. By measuring changing parameters over time based on community member interactions, we are able to follow the changing nature of the community and relate its changing complexity to maturity, actions of organization, and participation of its members.

Brown and Duguid (2000) used the term Network of Practice to describe the emerging relationship between individuals and geographically separated social networks. It is the participation of community members that is key to life of the community of practice (Lave & Wenger, 1991) where participation is inseparable from practice whether the members meet face-to-face or virtually. Facilitating the movements of legitimate peripheral participation may need to be a central role of a new community of practice and may be studied through the practices of the members and the actions of the organization. By studying engagement including lurking behaviors, participation, postings, downloads, and knowledge sharing, we may be

able to ascertain changes in members' participation over time revealing their movement from peripheral members to core members.

Communities are social spaces for member interaction. Social learning theory identifies the need in learning to observe and model the behaviors, attitudes, and emotions of others in order to avoid the difficulty and potential danger of learning in isolation (Bandura, 1977). Monitoring interactions within the community of practice, looking specifically for observed learning opportunities, may reveal its presence for community members and the organization. Members of the community of practice share the community's knowledge as well as a shared common understanding, practice, identity, and value (Shaffer et al., 2004). These also represent areas to be measured longitudinally in hopes of revealing the community's development over time and value to its members and organization.

The complex and evolving nature of communal relationships can be examined by looking for characteristics of sociability within the community of practice. Indicators in practice include sustained mutual relationship, shared ways of engaging and doing together, absence of introductory preambles, sense of belonging, mutual understanding of collective knowledge, mutually defined identities, development of local lore, shared stories, membership styles, and a shared discourse from a common perspective (Parker et al., 2010). Based on our understanding of the complex and persistent interactions of members of the community, it is useful to examine the nature of the social interactions. Working together, the community develops a greater understanding of a topic, task, or process and in much greater depth than one might alone, growing their organizational intelligence (Perkins, 2003). In this way, the

community of practice has become an effective organizational component addressing and solving important problems in the workplace (Lesser & Storck, 2001). Member contributions, critical to community development, are measureable through document postings, discussion responses, shared document creation, and from member stories.

Part Four: Facilitating Value within a Community of Practice

How can a community of practice be facilitated in such a way as to add value for both its members and the sponsoring organization? This section discusses the issues and benefits associated with organizational facilitation of a community of practice where facilitation is defined as guiding, encouraging, and managing the formation, growth, and maturation of a community for organizational and employee benefit.

Facilitation has been shown to be an important feature in successful communities of practice (Bielaczyc & Collins, 1999). Wenger, White, Smith, and Rowe (2005) used the term "technology stewardship" to describe the role an individual or small core group plays in embedding the community with appropriate technology. Facilitators of a community of practice focus not on individual behaviors but on the community as a whole and its learning environment (Abma, 2007) and so must have working knowledge of the domain in order to communicate meaningfully with community members and maintain focus (Wenger et al., 2002).

Typical online communities of practice contain a variety of components designed to facilitate communication, knowledge sharing, and community building, aligning with Lave and Wenger's (1991) original ideas. You will recall from the section on structures, that according to Wenger (2001), these consist of a community

homepage with information about domain, online chat or discussion board, a question and answer board, a member directory, a shared workspace for collaborating, discussing, and meeting synchronously, a location to store documents, site search function, participation monitoring, and division of labor functions such as allowing for the formation of subgroups and committees within the space while many now utilize social media in the form of tagging, blogs, tweets, and more. Wenger further discusses the features of the technical platform consistent in community use including being easily navigated and learned, having software compatible with multiple platforms, and being free or inexpensive for both users and organizers. Li et al. (2009) suggest that facilitating relationship building among members to promote knowledge exchange should be the organizational focus when managing the community. Gathering information about organizational efforts to do this may reveal what was done to promote it.

Facilitation in communities of practice can take different forms. Palloff and Pratt (1999) recommend, in instructional settings, that the group leader act as a "gentle guide," who helps to give discussions direction to help members generate meaning. Beyond facilitation, Powers and Guan (2000) emphasizes the critical role motivation and particularly intrinsic motivation plays in establishing self-direction of the group and discussions. During discussion and development of community knowledge, artifacts (symbols, procedures, rules, behaviors, technology, products) emerge as a result of experience and collaboration; all of which have been negotiated or produced by the community members (Wenger, 1998a). Members are likely to use the artifacts of their learning and knowledge differently than defined by their author

as the community of practice emerges and takes shape (Nachmias, Mioduser, Oren, & Ram, 2000; Wenger, 1998a). These types of emergent behavior (Johnson, 2001) develop out of member interactions and need, and can be guided by facilitation. Different types and levels of facilitation are necessary over the life span of the community.

Nickols (2003) has outlined how to best start a community of practice:

- Encourage communities of practice, but don't mandate communities of practice. A mandate to start a community of practice may create resistance and be perceived as just another management program
- Keep things as informal as possible. If management has strong expectations, then the community of practice should be converted to a project team. The team then will drive to satisfy management's demands instead of producing and sharing knowledge
- The premise of a community of practice is to support members' own work-related activities as well as those of the organization. The success of a community of practice depends on trust between and among its members
- Stay focused on the primary purpose of a community of practice, that is, to learn from each others as a result of sharing and collaborating
- Most communities of practice can successfully share information through telephone calls, emails, and occasional face-to-face meetings. Web pages with link might also be helpful

In the short time they have been part of the conversation about learning, communities of practice have become widely used by organizations to improve performance

(Wenger, 2006). Numerous researchers have written about the potential benefits to organizations when effectively integrating communities of practice into their existing knowledge management structure (McDermot, 2000; Pemberton, Mavin, & Stalker, 2007; Wenger & Snyder, 2000). For example, Kerno and Mace (2010) stress the importance of understanding communities of practice in their entirety in order to maximize the likelihood of success in the organization. They identified the possible benefits of cultivating communities of practice within organizations as: (a) their ability to be leveraged for competitive advantage, (b) strategic advantage, and (c) enhancing and improving performance. Wenger (2004) further argues that communities of practice are the cornerstones of knowledge management within the organization if facilitated properly.

While supporting the facilitation of a community of practice it is close integration of the community and the organization that can lend legitimacy, influence, and value to the community (Wenger et al., 2002) ultimately encouraging greater participation over time. As more members are brought into the community, often as peripheral members, they begin the cycle of participation and growth that may facilitate their movement from peripherality to centrality. While this may be true for some members, others work at the margins of the community.

Studying teacher professional development, Parker et al. (2010) found that the achievement of positive outcomes was dependent on support for both process and content. Additionally, they recorded the importance of organizational support for sustaining teacher's efforts over time where district approval lent a feeling of value to teacher participants. They identified the following factors in improving knowledge

sharing:

- Identify local knowledge systems
- Use existing social structures
- Find most appropriate media
- Involve communities in setting priorities
- Involve communities in production of information
- Incorporate new ideas but use local resources
- Build capacity of local groups to organize themselves and demand information
- Create opportunities for discussion and intermediary groups
- Better understanding of what makes knowledge and innovation systems work and become sustainable (Johnson & Khalidi, 2005)

Like Parker et al. (2010), Johnson and Khalidi (2005) identified organizational facilitation as a key to improved information and knowledge sharing and as critical components of community of practice success.

Along with direct ties to practice, facilitation for knowledge transfer and building is also central for the community's success and sustainability. Knowledge transfer is a critical factor in an effective community of practice (Wenger et al., 2002) making it critical for an organization to allow members of the community to have direct knowledge transfer unencumbered by external interference (Kerno & Mace, 2010). Kerno and Mace (2010) suggest that the primary goal for knowledge transfer is the development of, "codified, repeatable, and refined procedures that employees can use when performing their jobs" (p. 83). It is this critical link between what

occurs between the members of the community of practice and how their co-created knowledge can be effectively shared with others within the organization that can be successfully stewarded. How the organization shares and values the knowledge developed by the communities of practice it supports determines, in large part, their success and sustainability (Wenger, 2004). Successfully stewarded communities of practice have their shared wisdom distributed throughout the organization either formally as part of organizational "lessons learned" documents or "best practices" procedures (Kerno & Mace, 2010) or informally through "brown bag" discussions and "share-a-thons." Facilitators focus on getting members to share knowledge by knowing their strengths and interests, having regularly scheduled opportunities for members to share about themselves and their work, and by summarizing and synthesizing the discussions within the community, or asking others to do it.

Summary – facilitating of a community of practice. Facilitation has been shown to be an important feature in successful communities of practice by focusing on the community of practice as a whole rather than individual behaviors (Abma, 2007). Palloff and Pratt (1999) have recommend the group leader act as a "gentle guide" to give discussions direction and help members generate meaning and value from their interactions. Powers and Guan (2000) emphasizes the critical role motivation and particularly intrinsic motivation plays in establishing self-direction of the group that a facilitator needs to recognize and support. During discussion and the development of community knowledge, artifacts (symbols, procedures, rules, behaviors, technology, products) emerge as a result of experience and collaboration; all of which have been negotiated or produced by the community members and need

to be recognized and elevated by the facilitator as community built ideas (Wenger, 1998a).

One benefit from an organization supporting facilitation to nurture a community of practice is a close integration of the community and the organization that can lend legitimacy, influence, and value to the community (Wenger et al., 2002). Successfully stewarded communities of practice have their shared wisdom distributed throughout the organization either formally (Kerno & Mace, 2010) or informally. Collectively, a great deal can be learned from evaluating the facilitation of the community of practice and what influence it has on member participation and community functioning. This information may be gathered from outside the community - organizational facilitators – and from inside the community – central members – through direct observation and surveys of their perceptions of their own roles and that of others in the community. This review suggests a fruitful line of investigation would be to examine the behaviors of formal and informal leaders in facilitating participation, the interactions between longstanding members with each other and with novices, the members' movement from peripheral to central participation, shared product development, forward movement in knowledge-building, how the community sets priorities, how they move forward in accomplishing shared goals, how they deal with requests for information, and how they deal with new resources.

Chapter Summary

Through the examination of the literature, communities of practice have been identified based on theory and practice. The interactions occurring in communities of

practice, what structural components are necessary and sufficient for development of and to maintain a community of practice, and how facilitation of communities of practice promote member participation have been observed.

Communities of practice share some common characteristics. Lave and Wenger (1991), combining community and practice theory, formulating their vision of a community of practice. Wenger (1998a), continuing the exploration and defining of communities of practice, has recognized the importance of social learning for learners engaged in community learning settings. Wenger (1998a) emphasized the importance of learning to be and identity formation in the context of social community life and practice. We have seen how the theory underlying co-located communities of practice has been adapted to distributed virtual communities of practice. The key understandings of communities of practice have been applied to distributed communities as they become increasingly common in both personal and professional life.

Communities of practice require structure to support their work. The changing nature of interactions within communities (Dube et al., 2006) presents itself as a potential area for studying the evolving community of practice. By purposefully structuring the community according to our best understanding of communities of practice, an organization may be able to positively affect the outcome for both participating community of practice members and the organization. The literature suggests examining interactions (Wenger, 2004), knowledge building (Coppola, 1999), facilitation (Palloff & Pratt, 1999; Powers & Guan, 2000) and stories of success (Wenger et al., 2011).

Interactions in the online community of practice reveal its focus, knowledge building and sociability. Communities of practice develop around a shared understanding of what is important and grow to build knowledge related to the field (Wenger, 2002). Through their interactions, community members share information, experiences, insight, and advice (Wenger, 2004). Together, community members construct meaning through various constructivist strategies such as problem-based learning, structuring meaning from social activities, negotiated meaning, and building knowledge collaboratively (Coppola, 1999). Communities bring people together to interact, share, and grow. It is precisely these interactions that have the greatest potential to reveal the significance of participating in a distributed community of practice. Additionally, the organization may choose to strategically implement the community of practice as central to organizational or project success.

Successful communities of practice require purposeful and active facilitation. Whether acting as gentle guide (Palloff & Pratt, 1999) or motivator (Powers & Guan, 2000), facilitation is a necessary component of sustaining a community of practice. During discussion and the development of community knowledge, artifacts (symbols, procedures, rules, behaviors, technology, products) emerge as a result of experience and collaboration; all of which have been negotiated or produced by the community members (Wenger, 1998a) and are valuable in determining the success and value of the community of practice to its members and the sponsoring organization.

By defining communities of practice, we have grounded our knowledge in the long history of those who have worked together out of shared interests and goals. Interacting within the social structure of a community, members share experiences

and information and collectively grow their knowledge about their practice. Harnessing the power of community interactions, organizations can structure a community to meet its members needs while facilitating interactions in a manner consistent with the organizations goals for the community. Collectively, both the community members and the organization can find value in belonging to and participating in the community of practice whether co-located or distributed.

Chapter 3. Methods and Procedures

Introduction

This chapter explains the methodology used in this research to explore the impact of the online workspace component on the Earth Science E/PO community of practice. The chapter begins with a discussion of the research purpose and design. The design section is followed by a description of the data collection strategies, tools, and considerations for human subjects. The chapter concludes with a description of how the data was analyzed.

One of the three goals of the NASA Science Mission Directorate Earth Science Education and Public Outreach Forum is to have the members of the community engaged and leveraging resources, expertise, and best practices relevant to their outreach efforts. The workspace is supposed to support and facilitate online communication and collaboration. Part of how the Earth Science Forum is attempting to accomplish this goal is through an online workspace for its members. Anyone funded through a mission to do education and public outreach is part of the larger Education and Public Outreach community of practice and encouraged to participate in the online component, These educators are engaged in a "Learning partnership" (Wenger et al., 2011) where they share knowledge about effectively delivering educational materials to formal and informal educational institutions, educators, and the public.

NASA is the funder of the facilitated online workspace. NASA has contracted the task of managing the Earth Science E/PO Forum and its accompanying workspace. This organization was tasked with developing the online workspace and continues to actively facilitate community members' usage of it. Facilitation takes the

form of posting meeting notes to the online workspace, sending reminders and group emails from it, posting important updates and announcements on the message board, posting member bios as part of the "getting to know you" program, and encouraging members to participate in discussion forums, update their profiles, and utilize the other feathers available.

To date, research efforts on communities of practice have focused on identifying their key components (Wenger, 1998a), what is necessary to sustain their existence (Wenger et al., 2002), and how they can be leveraged for organizational growth and development (Hoadley & Kilner, 2003; Saint-Onge, 2011). Communities of practice have also been evaluated through longitudinal studies utilizing participant observation, interviews, and activity measures (Gongla & Rizzuto, 2001), case studies (Hildreth et al., 1998; Kimble et al., 2001), focus groups (Moreno, 2001), action research, and from a social capital framework (Lesser & Storck, 2001). More recently, Wenger et al. (2011) have proposed a framework for capturing value creation in communities.

Wenger et al. (2002) discuss the types of relationships that exist between the organization and the community of practice. Each successive level represents an increased acceptance by the organization and the associated challenges. The first type of community is referred to as "Unrecognized." As its name suggests, this type of community is not recognized by the organization or even it's members. The second, "Bootlegged," is typically only recognized to those inner circle members. The third type, "Legitimized," has been given official status by the organization and it is recognized for adding value. The fourth, "Supported," is, as its name implies, directly

supported by the organization through a variety of means, including allotted time for meetings, developing enhanced communication tools and channels, and/or financial support. The fifth type, "Institutionalized," has been designated an official component of the organization.

With the recent explosion of social networking channels for communication and collaboration between and among community members, it is necessary to consider what impact they are having on communities of practice. The online workspace established for the NASA Earth Science E/PO community is just such a mechanism. Therefore, it was necessary to determine the impact, if any, the workspace has on the co-located community of practice. In particular, the following questions were asked:

- What are the reasons for adoption by community members?
- When and why are members utilizing the workspace?
- What value has does it offer the individual and the community?
- What changes can be made to the existing workspace to improve it for the community of practice.

Metrics about the community were collected including those identified by Wenger (1998a) as any community of practice produces abstractions, tools, symbols, stories, terms, and concepts that reify something of that practice in a physical form. In addition, each member of a community of practice has his/her own experiences within and outside of the community. Over time, these personal experiences grow into a personal narrative of experience. Their stories are often comprised of their initial experiences, how they have grown over time, challenges faced, struggles

overcome, and value created from community membership (Trayner, 2010). Studying communities of practices to identify learning, knowledge creation, and value necessitates listening to and archiving these personal stories in addition to the community stories that have become part of the shared knowledge and experience. The stories are continually contested by community members and their meaning negotiated. Wenger et al. (2011) present value creation through social learning as located in an interplay between personal and collective narratives where value to the individual and organization can be revealed through the collection personal narratives and matching them other data sources.

Research Purpose

The purpose of the study was to better understand how an online community workspace component of a community of practice can support the community of practice itself. Much has been studied revealing the importance of communities of practice to organizations, project success, and knowledge management and some of these same successes have been shown to hold true for virtual communities of practice. While it is clear that online environments fostering communication and collaboration are rapidly becoming ubiquitous, the efficacy of these virtual communities of practice still needs to be examined further.

Research Questions

This study sought to answer the following research questions:

1) What role does the online workspace component play in the Earth Science Forum Education and Public Outreach community of practice?

2) Does the online workspace component support knowledge building within the community?
3) What value does the online workspace component add to the Earth Science Education and Public Outreach community?

These three questions and the approaches taken to answer them are detailed in the next section.

Research Design

This study used a mixed method exploratory design to gather quantitative and qualitative data from and about the community members to help understand the value of the online workspace for the education and public outreach community in hopes of exploring the effects of an online workspace component on the community of practice. By combining both quantitative and qualitative data, the researcher hoped to gain a more complete understanding of the research questions (Creswell, 2008) and explore how community members have utilized the online workspace component of their community of practice.

The specific activities communities of practice engage in that have been shown to be measurable include problem solving, requests for information, reusing assets, coordination and synergy, discussing developments, documenting projects, visiting members, and mapping knowledge (Wenger et al., 2002). All of these activities are potentially viable avenues of data collection and analysis to reveal change in a community of practice. Previous work at IBM (Gongla & Rizzuto, 2001) and by Hildreth and Kimble (2002) has helped to identify measurable outcomes in the use of communities of practice. Table 2 shows the relationship between this study's

themes and the questions being asked of the community members. The "X"s indicate where information collected is predicted to elicit information about how the online workspace component is achieving the theme areas.

Table 2

Relationship Between Themes and Questions

Questions	Themes			
	Knowledge Building/ Sharing	Value Creation	Interactions	Facilitation
Research Question 1) What role does the online workspace component play in the Earth Science Forum Education and Public Outreach community of practice?				
a) What is the role of the online forums in the ES Forum E/PO community of practice?	X	X	X	
b) How active are community members?			X	X
c) What is the nature and extent of community member engagement?			X	X
Research Question 2) Does the online workspace component support knowledge building within the community?				
a) How well does the online community support knowledge building within the community?	X	X	X	
b) What interactions occur in the online community and what role do they play in member participation and knowledge development?	X	X	X	
c) In what ways has the online community supported member interactions and knowledge sharing?	X	X	X	X

(Continued)

Questions	Themes			
	Knowledge Building/ Sharing	Value Creation	Interactions	Facilitation
Research Question 3) What value does the online workspace component add to the Earth Science Education and Public Outreach community?				
a) What value does the online community add to the organization and its members?	X	X	X	X
b) What is the level of belonging felt by the online community members?		X		X
c) How effective and sustainable is the online community?		X		X
d) What steps have been taken to promote sociability within the online community?			X	X

Data Collection Strategies

The researcher, as part of his professional work related obligations, submitted an IRB application to collect data from NASA's Science Mission Directorate Earth Science Education and Public Outreach Forum March 25th, 2010. The research request was granted from the American Institutes for Research Institutional Review Board IRB00000436 under project number EX00178 for a time period of 1 year from March, 2010 to March 2011. A research extension was filed in February, 2011 through the same organization and awarded March 30, 2011 for a period of 1 year and again in Debruary of 2012 for another years time. The review was granted exempted status for each year. The data collected after approval form IBR was used for analysis in this dissertation.

The researcher worked with the grantee, IGES, to contact community members and organizational members with survey requests through email utilizing the community email functionality of the online workspace itself. The collection of

these data is part of the evaluation plan for the Earth Forum since IGES (the contractor managing the Earth Science Forum) and NASA would like more information on their efforts to use online workspaces to accomplish their goals. All surveys were completed online with paper versions available where necessary. The collection of these data were covered under the IRB00000436 under project number EX00178 and the IRB approval of Pepperdine University.

Sources of Data

For 2010-2011, there were a total of 75 Earth Science Education and Public Outreach personnel. All personnel were given an account in the community workspace. Drupal automatically collects information about participant activities within the platform and those data are accessible by persons with administrative level access to the workspace. Data collected within the workspace are exportable by request to the site administrator who then granted access to the data for this study.

Surveys were be distributed electronically to the 75 Earth Science Education and Public Outreach personnel with access to the community workspace and requests for completion were be sent via the managing organization list serve. Interviews were conducted (via voice over IP) of a sample from the community with different groups representing different levels of use. Responses were both confidential and anonymous. The researcher also surveyed the workspace and reviewed its components and design.

NASA's Science Mission Directorate Earth Science Education and Public Outreach Forum is continually looking to connect Education and Public Outreach personnel with each other and the information they need to enhance their work

efforts. The forum holds a yearly retreat where personnel present their most up-to-date education and outreach efforts in "share-a-thons," interact with other educators, hear presentations from community members and leaders in the field, gather in smaller groups to address specific issues and needs, and network. Forum personnel also meet during "meetings of opportunity" held at different national and regional conferences where they have the chance to hear from NASA headquarters about changes in NASA education as well as interact in meaningful ways. The community workspace was designed to continue these types of interactions for the community as a whole and allow forum members the opportunity to share and learn from one another. This researcher has had the opportunity to attend two annual retreats and three meetings of opportunity.

Internal Reliability

Data from the community workspace was collected on only those members of the Earth Forum and not from the other three forums who also have community workspaces. This helped to ensure that members questioned were of the same community and had received the same information and experiences involving the workspace. Survey instruments were reviewed by experts in the field and refined accordingly.

External Reliability

External reliability was established by having three experts in the field review and give feedback on the data collection tools and methods used in the study. The researcher will ask Dr. Hilarie Davis, CEO of Technology for Learning Consortium, a professional evaluator who has worked on NASA educational program evaluation for

over 8 years, Theresa Schwerin, IGES project lead for the online workspace and Earth Science forum, and Dr. Margaret Riel of Pepperdine University and this researchers committee chair.

Data Collection Tools

Data was collected from five sources:

1. Structural and participation metrics from the online community
2. Community Member Survey
3. Interviews of community members
4. Organizational Member Survey
5. Researcher review of online workspace

The following is a description of the metrics and tools, the information collected from each, and how they were used to gather data to answer the research questions in the study.

Online Workspace Component

The online workspace component was developed using the Drupal open source content management platform. It was customized to meet the needs of the SMD forums for getting to know each other and the projects, communicating, interacting, archiving data and sharing resources. Drupal has built-in capabilities to follow user activity within the site including log-ins, postings, uploads and downloads, and other participation metrics. The researcher mined the data collected by the Drupal platform to gather information supporting the research including member participation, postings, log-in times and duration, communications, pages

visited, and document uploads and downloads – supporting research question investigating the role of the workspace in the community.

Community Member Surveys

The researcher developed the Community Member Survey to gather data from the Earth Science Education and Public Outreach online community participating members. The survey was designed to gather information from the community members about their experiences in the online community and how participation affected their work. The survey was made available online and requests were sent through the online workspace list serve to each member's email account. To provide an incentive, community members who complete the survey will be entered in a raffle. One prize valued at $200 was given to one community member chose at random from those that had completed the survey. Data collected from the Community Members Survey was used to explore all three of the projects research questions.

Community members who complete the survey were required to read and sign a statement of informed consent stating that they understand the study, its purpose, and their rights to decline to participate and have their responses excluded from the study. A copy of the informed consent form is included as Appendix B. A copy of the Community Member Survey is included as Appendix C.

Community Member Interviews

The researcher developed the Community Member Interview questions and protocol around the community assessment framework of Wenger et al. (2011). Specifically, the researcher utilized the Personal Value Narrative developed by

Wenger et al. By basing the interviews on their work, the researcher hoped to gain an understanding of the value the online workspace component provides for the community members as well as look for feedback from community members about improvements for the future. Data collected from the Community Member Interviews was used to explore the second and third research questions on the role of knowledge building and the value of these activities for the professional organization.

All community members were asked to complete the survey electronically. Additionally, three levels of users were determined from their use of the online workspace – heavy users, moderate users, and light users – contacted, and where willing and appropriate, interviewed. Each group had 5 interviewed participants. Responses were collected in secured files on the researcher's personal computer. A copy of the interview questions and protocol is included as Appendix D.

Organizational Member Surveys

The researcher developed the Organizational Member Survey to gather data from the sponsoring organization of the Earth Science Education and Public Outreach online workspace component. The survey items mirror those of the Community Member Survey while attempting to gather the unique perspective of those invested in the community at the organizational level. Data collected from the Organizational Member Survey was used to explore all three research questions.

Organizational members who complete the survey were asked to read and sign a statement of informed consent stating that they understand the study, its purpose, and their rights to decline to participate and have their responses excluded from the study. A copy of the Organizational Member Survey is included in as Appendix E.

Considerations of Human Subjects

Pepperdine University Institutional Review Board (IRB) was contacted and all requirements were completed for their approval. Pepperdine University IRB granted the researcher's proposal "exempt" status and approved the tools used in this study. Additionally, Pepperdine University IRB also granted this research the option of having participants indicate their understanding of participation electronically.

Analysis of the Data

This mixed method exploratory study has different types of data being collected from all sources including both quantitative and qualitative. Quantitative data was analyzed with various statistical methods to characterize the data and compare it where possible. Qualitative data was analyzed by Kernel principle component analysis (Cristianini & Shawe-Taylor, 2004) and quotes used to qualify findings and show the nature of the members' experiences. Interview responses were used to generalize about the participant experiences, look for responses about value, and give a user perspective to the online workspace component of the community of practice.

Analysis of Workspace Metrics

The online workspace was designed to collect member participation information automatically. The researcher was given administrative access to the online workspace and from there, able to mine the auto-collected data, collecting and transferring the pertinent data to spreadsheet for further analysis.

All numeric data collected was summarized for descriptive statistics including mean, median, mode, minimum, maximum, and standard deviation. Where

appropriate, matching data was compared for changes with Student's t-test. Data was also compared for correlations and influence of different variables through regression. It was believed that this information would help determine the frequency of member usage, possible changes over time, number and frequency of document uploads and download, discussion board participation and changes over time, subscriptions to news feeds and list serves, and time spent viewing different available material. These descriptive statistics on use illustrate how the community members utilized the online workspace over the first year.

Analysis of Survey Data

All survey responses with numerical data were also summarized using descriptive statistics including mean, median, mode, minimum, maximum, and standard deviation. Where appropriate, matching data was compared for changes with Student's t-test. Data was also compared for correlations and influence of different variables.

Written survey responses were transferred to a spreadsheet for analysis. Analysis consisted primarily of Kernel principle component analysis while quotes were used to qualify findings and show the nature of the members' experiences. Survey data was also compared to workshop metrics through correlations.

Analysis of Interview Data

All interview data went through a six-step process of evaluation.

1. The researcher personally conducted all of the interviews. Interviews took place over Skype and were recorded. The researcher took notes during the interviews and asked follow-up questions as necessary to further elicit a

response. The recorded Skype calls were referenced to insure that no ideas were lost in the original recording.

2. The data was segmented into idea units by the researcher. In most cases these were sentences, but in a few instances, they were parts of sentences or several sentences.
3. Response categories were created for the emergent themes of the responses and a code book with examples was developed
4. Inter-coder reliability was established by giving the code book to another researcher and they coded a random sample of the idea units. The coding process was refined until two coders reach an inter-coder reliability of 85% and then the rest of the data was coded by the researcher.
5. The responses were coded to the categories generated in step 3 with each unit coded as many times as appropriate while counted as present only once. No additional efforts were taken to ensure reliability of the coding as the interviews represent the exploratory phase of the research efforts.
6. Coding results were reviewed for emergent threads. Researcher identified patterns and trends in the data.
7. Data will be summarized and presented in Chapter 4 as part of the larger picture of the online workspace.

Interpretation of Results

The results from each source was summarized and then presented in their summarized format in table form. Further interpretation was conducted in the discussion section of this paper.

Validity and Reliability of Instruments

This study was validated by collecting data from multiple sources including data from community members, organizational members, the workspace, and the workspace design. By triangulating the different sources of data, the researcher hoped to construct a meaningful understanding of the complex dynamics occurring within the online workspace and how it supports or does not support the community of practice.

Chapter Summary

The purpose of the study was to better understand how an online workspace component supports a face-to-face community of practice. The study employed an exploratory mixed methods approach collecting and analyzing both quantitative and qualitative data collected from the workspace, the community members, facilitating organizational members and interviews.

Chapter 4. Data Analysis

Introduction

The purpose of this study was to investigate the role of an online workspace in a community of practice. To understand this role, the actual participation of the community members in the workspace was analyzed, community members were asked about their experience, and the community members who facilitated the development and use of the workspace were surveyed and interviewed. The results are presented in terms of members' activity in the workspace, their perceptions of knowledge building, and the value they ascribe to the workspace in their own work and the work of the community.

This study took an exploratory approach to researching the effect of the online workspace component on the community of practice. As much has been studied about communities of practice, their impact on organizations, and online involvement, this research focused on how, or if the introduction of an online workspace component into a pre-existing community of practice would effect it. In particular, the data collected focuses on the three areas previous literature has shown to be of critical importance to a community of practice. These include (a) member activity, (b) knowledge building, and (c) value. Before discussing the findings, discussed are the metrics and data sources used in this analysis including (a) online workspace metrics, (b) community member survey and interview, (c) faculty member survey, and (d) Kernel analysis.

Online Workspace Metrics

Workspace metrics were collected automatically by the workspace software platform. The researcher exported the metrics in Microsoft Excel format and performed summary statistics on them as necessary. From January 1, 2011 through December 31, 2011 online workspace metrics were collected. These are used primarily to talk about levels of participation.

Community Member Survey and Interview

The Community Member Survey was given electronically and results were down loaded in Microsoft Excel format. Summary statistics were performed where appropriate in addition to other statistical analyses necessary to characterize the data. Surveys were administered in January and February of 2012. A total of 22 community members completed the Community Member Survey.

All community members completing the Community Member Survey were asked if they were willing to participate in the Community Member Interview. To indicate their willingness, they gave their email address to be contacted about the interview. All of the community members who completed the survey indicated that they were willing to participate in the interview (100%). Community members were contacted in the order they had completed the survey and asked to participate in the interview. As part of the interview, members were asked to identify how often they participated in the online workspace. Responses ranged from very little or not at all to daily. Community Member Survey responses were reviewed for natural distributions based on usage where “highly active users” where those utilizing the online workspace at least 3 or 4 times each week, “average users” where those utilizing the

workspace at least once a week but not more than 3 times each week, and "infrequent users" where those utilized the workspace less than once a week with most using it once a month or less. Out of the 22 community members completing the Community Member Survey, 5 were identified as "Highly Active Users" (23%), 8 as "Average Users" (36%), and 9 as "Infrequent Users" (41%). See table 3 for the number and percentages of each user group.

Table 3

Distribution of Interviewed Community Member Workspace Usage

Workspace User Group	**Usage Description**	***N***	**%**
Highly Active Users	Utilizing workspace at least 3 to 4 times each week	5	23%
Average Users	Utilizing workspace at least once a week but not more than 3 times each week	8	36%
Infrequent Users	Utilizing the workspace less than once a week	9	41%
Total		22	100%

A total of 15 interviews were conducted from those completing the Community Member Survey (5 highly active users, 5 average users, and 5 infrequent users). Five of each user level were chosen to be interviewed because five was the number of all of the respondents identified as highly active users from the Community Member Survey. Interview data was collected in March of 2012, then went through a six-step process of analysis:

1. The researcher read through all responses.

2. Response categories were created for the emergent themes of the responses.
3. Coding was done of the responses matching them to the categories generated in step 2 independently by two researchers and their results compared for agreement. Where they did not agree, they discussed the discrepancy and came to an agreement on a code. Agreement was considered to be 85% or greater.
4. Coding results were reviewed for emergent threads by the primary researcher.
5. The primary researcher identified patterns and trends in the data.

Once all responses were coded for usage they were labeled accordingly and then arranged into groups for coding, combining highly active users together, average users together, and infrequent users together. Responses were then reviewed for emergent themes and response categories developed. These response categories were used to code all responses from all levels and all items. Once the researcher coded all of the responses (R1), the codebook and responses were given to another researcher and she repeated the coding (R2) without knowledge of the first researcher's coding. The two coded documents were compared and the two researchers discussed any discrepancies to come to agreement on the appropriate code. Discussions continued until a researcher correlation of coding above 85% was established (final correlation coefficient between the two researchers was 0.879 or 88%).

Facilitating Member Survey

The Facilitating Member Survey was also given electronically and similar to the Community Member Survey, results were down loaded in Microsoft Excel format. Summary statistics were performed where appropriate in addition to other

statistical analyses necessary to characterize the data. A total of five (5) Facilitating Member Surveys were completed.

Kernel Analysis

Kernel Analysis is a form of pattern analysis utilized to determine general patterns of relationships in the data. Kernel analysis was used in the analysis of the open-ended responses in both the Community Members and Facilitating Member surveys as well as with the responses from the community member interviews. Kernel analysis was conducted similar to coding but without a second reviewer. Responses were categorized based on their content and/or meaning and then presented in tables with categorized responses, number of related responses, and percentages of response numbers.

Summary

There were a total of for sources of data utilized in this study. The online workspace metrics were exported directly from the online workspace utilizing Google Analytics. The Community Member Survey was given to all 75 community members electronically as a link embedded into an email. One follow up email was sent to community members again using email. A total of 22 community members completed the survey for a return rate of 29%. The Facilitating Member Survey was given to all 7 facilitating members of the online workspace. Five of the 7 community members completed the survey for a return rate of 71%. Five highly active members of the online workspace, 5 average users, and 5 infrequent users were selected for follow up interviews. When one of the original contacted community members were not able or willing to participate in the follow up interview, another member from the same user

group was chosen and contacted. This process continued until five interviews were completed from each user group. Table 4 summarizes all of the data sources and number collected from each.

Table 4

Data Source and Response Summary

Tool	Number Completed	Total Population	Return Rate
Community Member Survey	22	75	29%
Facilitating Member Survey	5	7	71%
Community Member Interview	15	15	100%

The findings form these data sources were organized into three parts aligned with the research presented throughout this work. Part 1 presents the data on Activities and Interaction within Communities of Practice. Part 2 presents the data on Knowledge Building and Interactions Within A Community of Practice. Part 3 presents the data on Facilitating Value within a Community of Practice.

Part 1: Activities and Interaction within Communities of Practice

To help determine the role of the online workspace in the Earth Forum community of practice, data were gathered on community member activity in the workspace, the role of the online workspace in the community of practice, and the nature and extent of their engagement. Data was gathered from the Community Member Survey, Facilitating Member Survey, community member interviews, and workspace metrics.

Community Member Activity in the Online Workspace

The workspace metrics show progressively greater use by more people during its first full year of use. From January 1st, 2011 though December 31st, 2011, the Earth Forum Workspace had a total of 1563 visitors with an average of 130 each month. During the same time period, there were a total of 20,152 page views, averaging 1679 each month. The number of unique visitors increased an average of 8.2 each month from January through December with an average monthly variance of 0.617 ($R^2 = 0.617$). Table 5 shows how the unique visitors and page views increased steadily over time. Figure 2 below it shows this strong relationship between time and unique visitors to the workspace graphically.

Table 5

Monthly Visitors to Online Workspace

Month	Number of Unique Visitors	Total Number of Visits	Total Page Views
January	71	1204	1708
February	79	1275	1552
March	95	1422	1866
April	108	1234	1614
May	139	1424	1778
June	116	1201	1291
July	144	1131	1243

(Continued)

August	197	1682	1826
September	159	1476	1983
October	171	1562	1899
November	143	1454	1876
December	142	1246	1518
Total/Average	1563/130	16311/1359	20153/1679

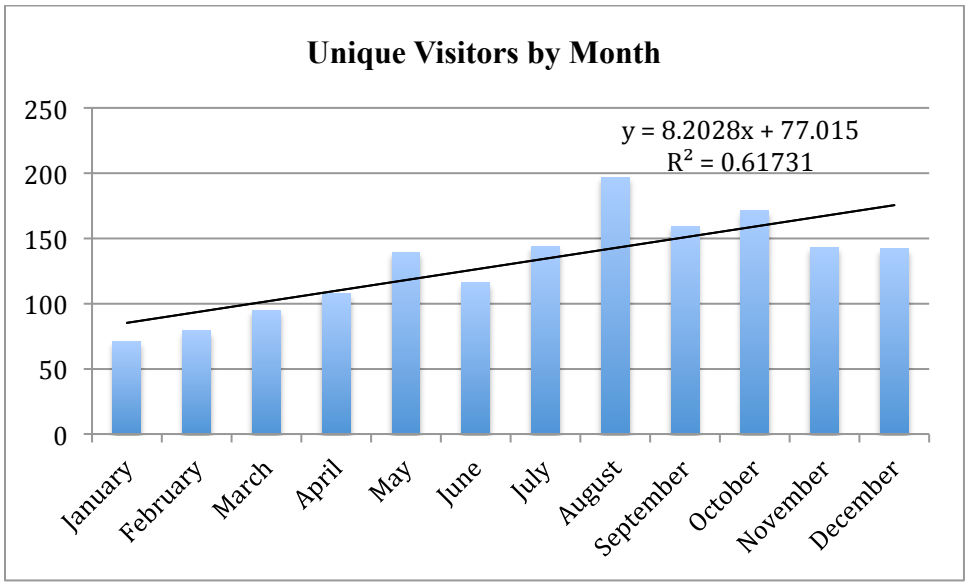

Figure 2. Unique monthly visitors to online workspace

The survey data from members provided further information about what may have limited growth, i.e., barriers to activity. When asked about the limiting factors to their participation in the online workspace, two thirds of the responding members reported that it was time (37%) or navigation (29%). While cited less often, not enough useful information (11%) was also given as a limiting factor. Very few community members reported that lack of interest (7.9%), having no live chat function (7.9%), personal search (5.3%), having no unique information (2.6%) or the

technology (0%) were limiting factors to their participation in the online workspace. Table 6 shows these limiting factors in order from those cited most often by community members to those cited the least.

Table 6

Limiting Factors to Community Member Participation in the Online Workspace (*N*=22)

Response Choice	Percent (%) Each Response was Chosen			
	Highly Active Users (*N*=5)	Average Users (*N*=8)	Infrequent Users (*N*=9)	All Users (*N*=22)
Time	40%	100%	44%	64%
Navigation	0	50%	33%	32%
Not enough useful information	20%	25%	11%	18%
Interest	20%	13%	11%	14%
No live chat function	0	0	33%	14%
Can't search people by expertise	0	13%	11%	9.1%
No unique information	0	13%	0	4.5%
Technology	0	0	0	0
Other	20%	50%	67%	55%

When asked to offer additional information about factors that were limiting their participation in the online workspace, community members reported that they were not aware of it, it was difficult to figure out, too complicated, or they were "not

sure of the value for me." Table 7 shows how often these limiting factors were mentioned by community members in their open-ended responses.

Table 7

Limiting Factors for Community Member Participation in the Online Workspace Reported in the Survey Responses (*N*=11)

Survey Question: What were the greatest limiting factors to your participation in the online workspace? (open responses)	**% of Responses**
Not aware	36%
Not functional	18%
Not intuitive	18%
New member	18%
Overkill for posting documents	9.1%

While time and navigation may be limiting factors, community members were still willing to continue to participate with none of the respondents reporting that they were not willing to participate. Figure 3 shows the mean response of community members from the community member survey question about willingness to participate. Highly active users rated their willingness to continue to participate the highest with a mean response of 4.8 and willingness to participate decreased with decreased participation.

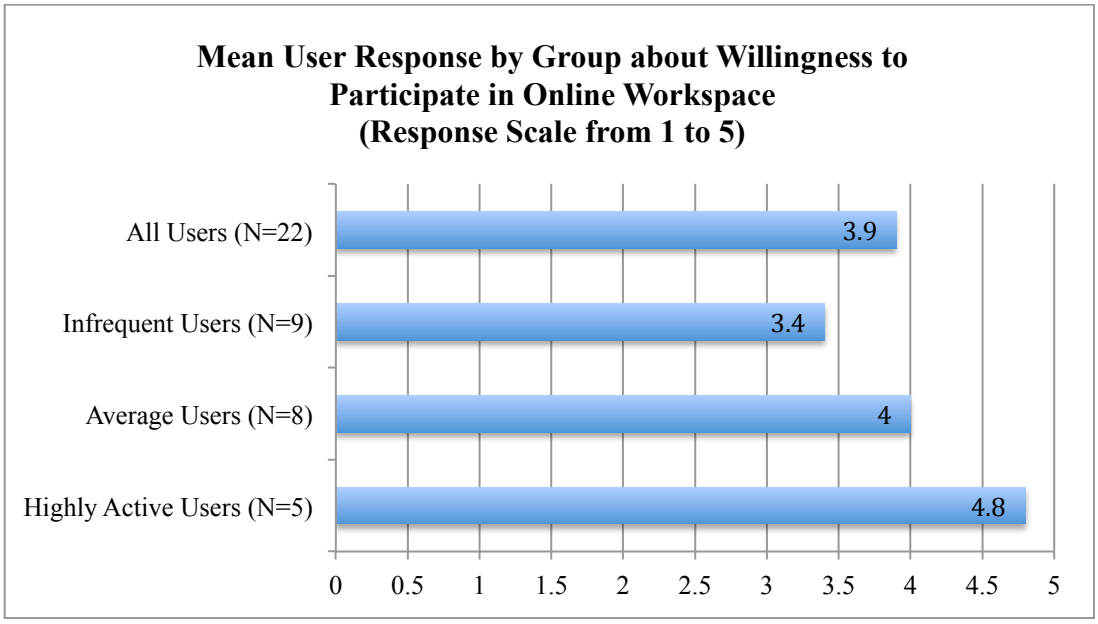

Figure 3 Community members willingness to continue to participate in the online workspace (1=not willing to participate -5=very willing; *N*=22)

Strategies for Improving Participation

As part of the efforts to promote participation among the community members, the facilitating members described a number of strategies that they employed. Table 8 lists these strategies indicating how many of the facilitators used the different strategies.

Table 8

Strategies Employed by Facilitators (N=5) to Promote Participation of Community Members in the Workspace

Strategies reportedly used by four facilitators
• **Different members**
• **Announcements**
• **Directing them to the workspace**
Strategies reportedly used by three facilitators
• **Telecons that sought to inform**
• **Encouraged profile completion**
• **Posting critical information in the workspace for members to utilize**
Strategies reportedly used by two facilitators
• **Correcting usability issues**
Strategy reportedly used by one facilitator
• **Promoting leadership from within**

All of these efforts were part of the facilitating members' continuing efforts to promote the workspace and encourage participation. These address several of the barriers the community members reported. While some issues can be more easily addressed by the facilitating members such as navigation and workspace content, others are more difficult such as time to spend in the workspace. Through better utilization of the technology, making page navigation clearer, incorporating archives,

and promoting items of greatest importance on the home page may alleviate user technology issues. While time constraints may be alleviated somewhat by improvements in the technology, it remains a difficult issues to address for users.

Nature and Extent of Community Member Engagement

While community members may be challenged by time and navigation constraints when participating in the workspace, they are still also engaged and at various levels. To determine the nature and extent of their engagement, data was collected on workspace usage and member activities. Respondents spent an average of 6 minutes and 11 seconds on each of their visits to the site. Average visitors time on the site decreased slowly from January (average of 8 minutes and 17 seconds) to December (average of 6 minutes) and an R squared value of 0.166 suggesting a highly variable change from month to month. While the average time on site decreased slightly, the percentage of new visitors to the site rose consistently from a low of 14% in January to a high in 42% in July (average of 29, standard deviation of 8.94), the bounce rate remained fairly constant with an monthly average of 43% and a standard deviation of 3.55. A "bounce" occurs when a visitor to the website views a single page only and does not navigate to any other page on the site. Bounce rate is a measure of the number of site visitors that bounce from the site after viewing the single page. Content on the home page was updated daily or weekly with new information including announcements, meeting notes, project updates, and more. Users may have been looking to the home page for an update on what was happening in the community and see little look at an additional pages on the workspace. Table 9 shows the average time members spent on a page, the bounce rate and the percentage

of new visitors each month. The graph in Figure 4 shows a slight overall downward trend in the average amount of time members spent each month. The graph in Figure 5 shows a strong upward trend in the percentage of new visitors per month.

Table 9

Average Time on Page, Bounce Rate, and Percent New Visitors to Online Workspace by Month – 2011

Months of 2011	**Avg. Time on Site**	**Bounce Rate %**	**% New Visitors**	**Total Number Visitors**
January	08:17	41%	14%	1204
February	07:03	45%	16%	1275
March	06:28	42%	18%	1422
April	06:28	39%	24%	1234
May	05:39	44%	31%	1424
June	05:06	49%	29%	1201
July	05:12	50%	42%	1131
August	05:21	39%	38%	1682
September	06:31	40%	34%	1476
October	06:07	44%	34%	1562
November	06:55	45%	30%	1454
December	06:00	44%	35%	1246
Total/Average	06:11	43%	29%	16311/1359

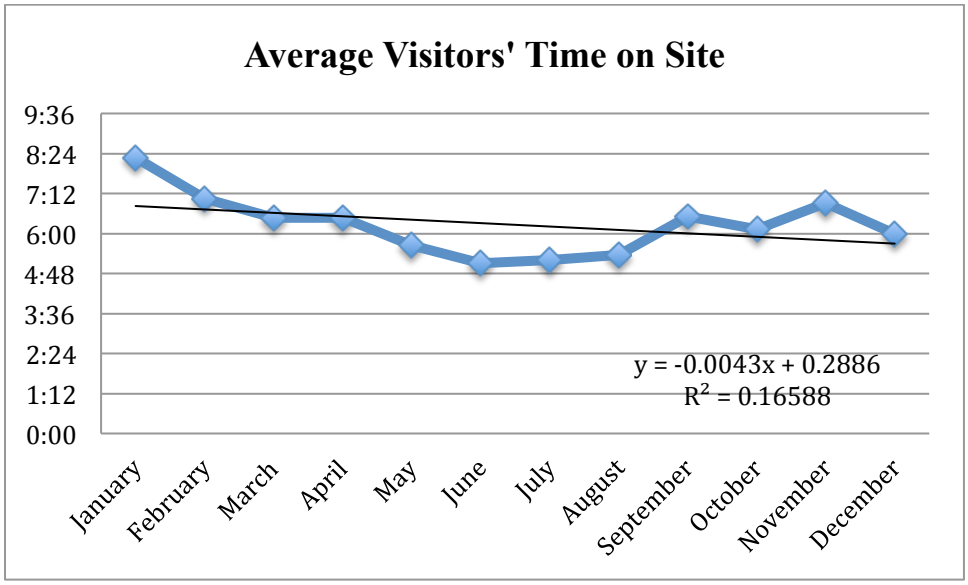

Figure 4. Average visitors time on online workspace by month

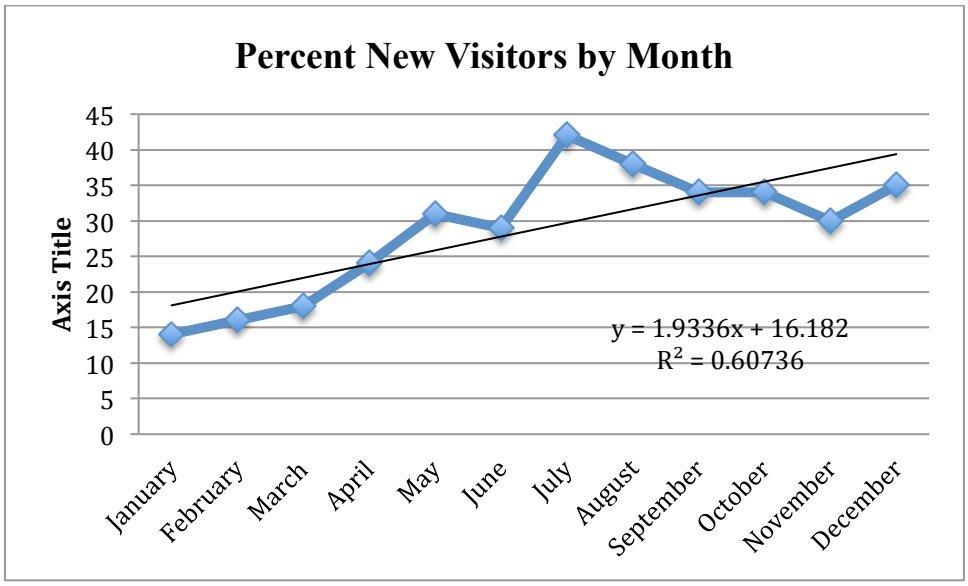

Figure 5. Percent new visitors by month to online workspace

In addition to the web analytics on time and visits to the workspace, responding community members were asked about the interactions they have had in the workspace. Overall, most respondents only participated in each of the different activities once or twice. Access of individual profiles occurred mostly at the beginning of a member's usage of the workspace (91% of the responding community

members reported accessing profiles at least one or two times) and perhaps when a person needed to be identified, but this was not occurring on a regular basis. Sharing scheduled events happened a bit more frequently for some (55% of the responding community members shared an upcoming event one or two times) while this was also was not a regular activity. The sharing of resources occurred more frequently (14% community members sharing twice a month, 23% sharing once a month, and 55% sharing once or twice during the year). Collaborations with colleagues occurred the most frequently (14% collaborating twice a month, 23% once a month, 41% once or twice during the year). Highly active users were logging in daily or every few days and reading about community news and events so they did more of each type of activity. Table 10 shows the how often community members did each kind of activity.

Table 10

Number and Percent of Community Members Participation in Activities Showing Engagement in the Online Workspace (*N*=22)

Community Member Activities	1/wk	2/mo	1/mo	1-2 times	No Res.	**Total**
Accessed individual profiles			6	14	2	22
			(27%)	(64%)	(9.1%)	100%
Shared upcoming events		4	2	12	4	22
		(18%)	(9.1%)	(55%)	(18%)	100%
Shared resources	1	3	5	8	5	22
	(4.5%)	(14%)	(23%)	(36%)	(23%)	100%

(Continued)

Community Member Activities						
Collaborate with colleagues	1 (4.5%)	3 (14%)	5 (23%)	9 (41%)	4 (18%)	22 100%

Role of the Online Workspace in the Earth Science Forum E/PO Community of Practice

To build a community of practice, members need to feel they belong in the community. During the interview, community members spoke about how they had connected with others of the community that they had previously been connected to. They suggested that the connections they were making helped them to feel more like they were part of a larger community and that when they arrived a face-to-face events they had made new working relationships as well as friends. When asked is the online workspace helped in building a sense of community in its members, 14 (67%) agreed, while 7 (33%) disagreed. For those who responded yes, 44% further explained that they were building feelings of a community by participating, 33% said that the information it provided was useful, and 22% said that it was a common meeting place to exchange ideas with others. For those who said "no," that the online workspace does not make them feel like they belong to the community, 43% explained that they get no sense of community from the workspace, 29% indicated that they feel part of the community through other means, and there was another similar sized group who felt that there was not much discussion or interaction occurring there (29%).

During the interviews, community members reported that the information available was valuable, that the workspace was becoming a common meeting and exchange location, and that they were beginning to feel a sense of belonging as a result of participating. Those that felt there was no increase in a sense of belonging from participation in the workspace felt part of the community through other means and reported that there was not much discussion or interaction.

To further explore the feelings of community members towards the online workspace, members were asked if participation in the workspace helping them to further develop their knowledge and expertise. Of the 21 responding community members, 11 (52%) said that participation had helped develop their knowledge or expertise and 10 (48%) said that it had not. Member explanations about participation helping develop their knowledge or expertise focused on available resources and learning from others while member explanations about participation not helping focused on limited time, using other means, and more sharing more than receiving.

During the interview, participants were asked to describe a meaningful activity that they had participated in. Activity descriptions were read and coded. Two of the highly active users reported working in new ways as part of their activity descriptions. Activities coded as "New ways of working" include anything that involved a way of sharing information in the workspace. Highly active users reported adding information/knowledge, working in new ways, participating in their working group, and helping other community members. They described finding new ways of being active participants of the community through the workspace. Average users reported adding information/knowledge, working in new ways, participating in their

working group, and organizing and getting resources for information. Infrequent users reported getting resources for information, working in new ways, or not using the space at all while not sharing any stories about how they were doing things in new ways. Table 11 shows the number of members who reported doing the various activities in the workspace arranged by user activity level.

Table 11

Differences in User Activities Coded form Community Member Interview Prompt by Level of Usage (*N*=15)

Prompt: Describe a meaningful activity in which you participated and your experience of it.	**Frequency each item was mentioned**
Highly Active Users (*N*=5)	
Add information/share information/knowledge	3
Participating in discussion board, new way of working	2
Participating in working group	2
Helped fellow community member	1
Making connections	1

(Continued)

Prompt: Describe a meaningful activity in which you participated and your experience of it.	Frequency each item was mentioned
Average Users (*N*=5)	
Organization	2
Participating in working group	2
Add information/share information/knowledge	1
Participating in discussion board	1
Resource for information (contact information/documents/news/announcements)	1
Infrequent Users (*N*=5)	
Resource for information (contact information/documents/news/announcements)	3
Participating in discussion board	1
Not using space/other tools available	1

Summary Part 1: About Activities and Interactions in the Workspace

In order to gather information about activities and interactions within the online workspace data was collected about member activities, factors affecting activity, their willingness to continue to participate, how they were participating, interactions occurring within the workspace, and finally the role the workspace was playing as part of the larger community of practice. The data shows that members are becoming more active in the workspace and willing to continue while still challenged

with time and navigation. Overall, activities are limited in the workspace with only the most highly active members logging in daily and making the workspace the nexus of their community involvement. The role of the workspace is emerging as a place to help members feel they belong and to a lesser extent help them further develop their knowledge and expertise. Again, the most highly active users the workspace had taken on a role different from average and infrequent users and in so, provided more meaning for them.

Part 2: Knowledge Building and Interactions within A Community of Practice

Once members are active and engaged within the community, they can play important roles in knowledge building; a necessary component of a community of practice. To help determine whether the workspace supports knowledge building within the community, data were gathered from community members about the resources that an online activity had produced, how workspace resources are used, support for knowledge building in the online community, interactions that occur, and ways interactions are supported.

Resources That the Online Activities Produced

It was hypothesized that engaging in the online workspace would result in the production of resources for the community. Interviewed community members (N=15 total) were asked to describe a specific resource that an activity had produced. Highly active users (N=5) reported producing community resources, documents, new ideas, and a feeling of community. Average users (N=5) reported gaining awareness, accessing documents, getting feedback and ideas, and information being produced. Infrequent users (N=5) reported using documents, accessing profiles, developing

awareness of forum activities, or nothing has been produced. Table 12 shows the resources interviewed community members described as being produced by their level of activity in the workspace.

Table 12

User Descriptions of Resources Produced from Workspace

Interview prompt: Describe a specific resource the activity produced.	**Frequency each item was mentioned**
Highly Active Users (*N*=5)	
Community resource	2
Documents	1
Feeling of community (membership/team)	1
New ideas	1
Average Users (*N*=5)	
Documents	2
Awareness	1
Feedback	1
Ideas and Information	1

(Continued)

Interview prompt: Describe a specific resource the activity produced.	Frequency each item was mentioned
Infrequent Users (*N*=5)	
Documents	2
Profiles	1
Awareness	1
None	1

How Workspace Resources Were Used

Once a resource was produced – documents, teaching guides, or instructions – in order to benefit the community it needed to be utilized, or put into practice. Interviewed community members (N=15) were asked to tell how the workspace resources were used in their practice and what enabled their usage. Responses were read and coded with Highly active users reported they used the resources in collaboration efforts, to stay up to date and informed, to align their work with that of the organization, for forum specific information, and to reshape their practice. Average users reported using the resources in synchronous and asynchronous work, collaboration efforts, to see others' thinking, and to stay up to date. Infrequent users reported using the resources to align with community members, share with colleagues beyond the online community, and to keep up to date. Table 13 shows how users of different activity levels responded.

Table 13

Resource Utilization By Interviewed Community Members

Interview prompt: How did you use the resources developed in the online workspace in your practice?	**Frequency each item was mentioned**
Highly Active Users (*N*=5)	
Collaboration efforts	2
Forum specific information	2
Up to date/informed	2
Alignment with organization	1
Reshaped practice	1
Average Users (*N*=5)	
See others thinking/ideas	2
Synchronous and asynchronous work/timing	2
Collaboration efforts	1
Up to date/informed	1
Infrequent Users (*N*=5)	
Not sure	2
Alignment with community members	1
Shared with colleagues beyond online community	1
Up to date/informed	1

Support for Knowledge Building in the Online Community

To facilitate knowledge building research suggests it is necessary to promote member engagement through proper facilitation. To support knowledge building in the Earth Forum facilitating members organized community members into groups and asked that they meet in the workspace as part of their collaborative efforts. Additionally, facilitating members engaged in active facilitating by contacting members directly about information and events occurring in the workspace, information recently posted, tools developed, profiles updated, etc. Table 14 lists the type of active facilitation conducted and how often it was conducted.

Table 14

Facilitating Member Activity to Promote Community Engagement with the Online Workspace

Activity Description	Frequency
Community announcements	Daily – Weekly
Discussion thread monitoring and posting	Daily – Weekly
Forum News and Headquarters updates	Weekly
Announcements from community members	Weekly
Community member profile of the week	Weekly
Email reminders with workspace links	Weekly
Professional development opportunities	Monthly
Assignment of members to working groups	Project specific
Document posting	Ongoing

When asked in an open-ended question what they felt was the purpose of the online workspace, 73% of the responding community members reported that it was to promote knowledge building. Kernel analysis of open-ended responses from the facilitating members' (N=5) survey about components of the workspace intended to help knowledge building in the community, showed that 3 of the 5 respondents cited file sharing/posting documents. Fewer facilitators reported that components for promoting knowledge building were community news and announcements, discussion boards, and professional development sessions (2 of the 5). As 1 respondent wrote, "All of it, if used properly. The entire point of the workspace is to get information out to the SMD forums." Table 15 shows the response counts from the responding facilitating members.

Table 15

Activities Intended to Promote Knowledge Building Among Community Member

Components of the online workspace facilitating community members reported contribute to knowledge building in the community	**Number Reporting**
File sharing/posting documents	3
Community news and announcements	2
Discussion board	2
Member profiles	2
Professional development sessions/opportunities	2
Monthly tag-up tutorials	1

Collaboration is a necessary component of knowledge building in a community of practice. Community members (*N*=22) were asked to indicate how often they did different activities in the workspace. Community member activities focused around collaborating with colleagues (82% at least once) and sharing resources (78% at least once). Table 16 shows how often community members did different collaboration activities.

Table 16

The Number and Percentage of Community Members Engaged in Knowledge Building Activities in the Workspace (*N*=22)

Activities in the workspace	**Number and Percentage of Respondents**					
	1/wk	2/mo	1/mo	1-2 times	No Response	Totals
offered knowledge or experiences		2 (9.1%)	5 (23%)	9 (41%)	6 (27%)	22 100%
Gained any skills		1 (4.5%)	5 (23%)	11 (50%)	5 (23%)	22 100%
Shared resources	1 (4.5%)	3 (14%)	5 (23%)	8 (36%)	5 (23%)	22 100%
Collaborate with colleagues	1 (4.5%)	3 (14%)	5 (23%)	9 (41%)	4 (18%)	22 100%

Knowledge Development Through Interactions

Knowledge often develops out of interactions between members of communities of practice and is often a deliberate intention of the interaction. If properly supported and encouraged these interactions occur regularly. Community members were asked to indicate which items on a list they felt best represented the purpose of the online workspace. The majority of responding community members reported they felt the purpose was to provide a place to interact with other E/PO's (82%) and there was no significant difference among the different level of users. All highly active users (100%) felt the purpose was for building teams, cooperating with other forum members on projects, sharing documents, and providing an archival space for community artifacts. This differs from average and infrequent users who were less definitive as to what they felt the purpose was. No statistical testing was done between groups as the numbers were too small for statistical comparisons. Table 17 shows the results of the community member responses.

Table 17

Purpose of the Workspace as Identified by Community Members

What do you feel should be the purpose of the online workspace or what do you think it is for?	**% Of Respondents By Group**			
	Highly Active Users (*N*=5)	**Average Users (*N*=8)**	**Infrequent Users (*N*=9)**	**All Users (*N*=22)**
Provide a space to interact with other E/POs	80%	88%	78%	82%
Provide archive of forum information and activities	100%	50%	67%	68%
Provide current news, events, data calls from headquarters	60%	75%	67%	68%
Share documents	100%	50%	56%	64%
Cooperate with other forum members on projects	100%	50%	44%	59%
Build teams	100%	25%	44%	50%
Share individual information	40%	38%	67%	50%
Increase sociability among forum members	20%	38%	44%	36%

Online Community Support of Member Interactions and Knowledge Sharing

In order to effectively interact with other community members and build knowledge, members need to able to easily navigate the workspace. Responding community members initially rated their ability to navigate the workspace at a mean of 2.4 on a scale form 1-5 with 5 being the highest. After more than a year of using the workspace the average rating given to workspace navigation was a 3.3 for the same group (p value of <0.01). Table 18 shows the average rating from all users and by users group while Figure 6 shows all the comfort levels for the two points in time.

Table 18

Average Respondent Ratings of Comfort with Using Workspace by Level of Usage (Scale of 1-5)

	Rating – First Began	Rating - Now
Highly Active Users (*N*=5)	2.6	3.2
Average Users (*N*=7)	1.9	3.1
Infrequent Users (*N*=8)	2.8	3.4
All Users (*N*=20)	2.4	3.3

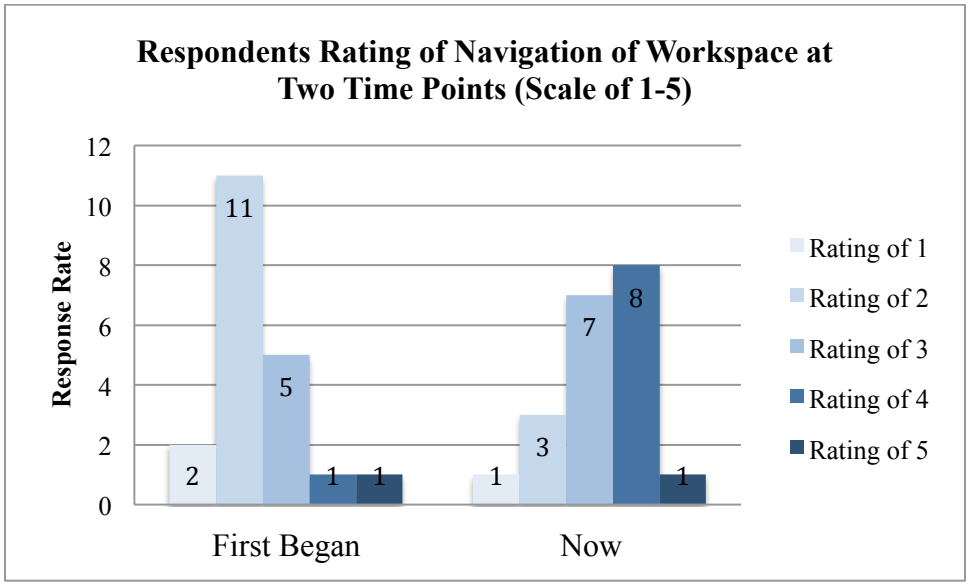

Figure 6 Respondent ratings of navigations of the workspace at two time points (*N*=20)

Facilitation in Knowledge building

To further explore knowledge building and interactions, workspace facilitators (N=5) were asked how the online workspace had supported the work of the Earth Science community. They reported that it had promoted productivity and sharing (3 of the 5), cultivated conversations (2 of the 5), helped members find other members with similar expertise (2 of the 5), informed the community (2 of the 5), and promoted a sense of belonging and community (1 of the 5), all meaningful and important activities to promote knowledge building through interactions. Table 19 shows the percentage of members who chose each area of support.

Table 19

How Facilitators Report the Workspace Supports the Community (*N*=5)

How the Online Workspace has Helped Support the Work of the Earth Science Community According to Facilitators	Number of Reponses
Promotes productivity/sharing	3
Cultivates conversation	2
Finding other members with similar expertise	2
Informs community	2
Promotes a sense of belonging/community	1

Community members were also asked to rate their experience and perceptions of the workspace. Of the responding community members, users rated the workspace as useful (3.4), attractive (3.3) and having information they expected (3.2) on a scale form 1-5 with 5 being the highest. The most active users found the workspace to most useful (3.6). Table 20 shows that the mean scores for each user group and for all users.

Table 20

Experiences and Perceptions of Community Members (Rated on a Scale from 1 – 5 with 5 as the Highest; N=22)

Community Member Experiences and Perceptions of the Workspace	Highly Active Users (*N*=5)	Average Users (*N*=8)	Infrequent Users (*N*=9)	All Users (*N*=22)
The workspace is useful	3.6	3.3	3.4	3.4
The workspace is attractive	3.4	3.1	3.3	3.3
The workspace has the information I expected	3.2	2.9	3.6	3.2
It is easy to navigate to the resources I am search for	2.0	2.6	3.0	2.6
The workspace layout is intuitive	2.2	2.3	2.5	2.4

Summary Part 2: Knowledge Building and Interactions within A Community of Practice

Knowledge building is a necessary component of a community of practice and promoting it a necessary activity for facilitation. Data collected from surveys and interviews explored activities that took place in the online workspace, their outcomes, and how resources were utilized. Data reveal that highly active users have produced what they describe as "resources," while average and infrequent users report producing "documents." Highly active users have used the resources they developed for collaborative efforts. Facilitation promotes engagement in the workspace, which

in turn fosters resource development for the online workspace, which then makes the workspace more useful to members. Less apparent is the link between user activity level and knowledge building within the online workspace.

Part 3: Facilitating Value within a Community of Practice

Part three presents data revealing how value, both for the individual and organization, is facilitated and developed through the online workspace. To help determine the extent to which the workspace supports value development within the community, data were gathered from community members by way of the Community Member Survey and community member interviews. Data from these sources sheds light on the effect of the workspace resources on individual's success, the effect of their participation on the success of the community, the effect on their definitions of success, the value the workspace for them and the organization, their sense of belonging and how it helps to promote value, and how effective and sustainable they think the community is.

Effects of Resources on Participant Success

The value of a community is often individualistic. To help explore value for individual members of the community, community member interview participants were asked to describe how the resource affected their success. Responses were read and coded. Highly active users reported coordinating with their team and collaborations, improved products and outcomes, and facilitating discussions. Average users reported improved productivity, simplified efforts, and making personal contributions. Infrequent users reported that the resource had not affected their success, but had helped with alignment, and simplified their efforts. Table 21

shows the detailed results for high, average, and infrequent users. These data support the earlier trends toward highly active users having different perceptions than infrequent users of the workspace.

Table 21

How Resources Affected Interviewed Community Member Success (*N*=15)

Responses By User Category	Count
Highly Active Users (*N*= 5)	
Coordination of team/collaboration	3
Improving products/outcomes	2
Facilitated discussion	1
Average Users (*N*=5)	
Improved productivity	2
Simplified efforts	2
Personal contribution	1
Infrequent Users (*N*=5)	
Has not/neutral	3
Alignment	1
Simplified efforts	1

Effects of Individual Participation on the Success of the Community

Communities of practice thrive when the members both benefit individually feel they are contributing to the overall success of the community. With this in mind, interviewed community members were asked if their participation contributed to the success of the Earth Forum Community. All of the highly active users reported that it

had (N=5), three of the average users reported it had, and none of the infrequent users reported it had. Highly active users reported that it contributed by helping others, improving community work quality, improving efficiency, and providing public acknowledgement. Three of the five average users (60%) reported that participation contributed to the community by helping others, and making it easier to communicate and provide feedback. None of the infrequent users reported that their participation or lack there of contributed to the success of the Earth Forum Community (see Table 22 for detail).

Table 22

How Participation Contributed to the Success of the Earth Forum Community by User Activity Level (*N*=15)

Interview Responses By User Category	Count
Highly active Users (*N*=5)	
Helping others	3
Improved community work quality	1
Improved efficiency	1
Public acknowledgement	1
Average Users (*N*=5)	
Helping others	2
Easier to communicate/provide feedback	1

(Continued)

Interview Responses By User Category	Count
Infrequent Users (*N*=5)	
Not using	2
Help community	1
Repository	1

Effect on Participants' Definition of Success

Value may also be tied to an individual's definition of success. Interview participants were asked to describe if and how their understanding of success changed as a result of their participation in the online workspace. During the community member interviews, highly active users (N=5) reported that they were expanding into social media, had improved connections resulting in more success, had more community focused success, and personal growth and use of collaborative space. Average users (N=5) reported the sharing of ideas, personal growth, use of collaborative space, improved connections resulting in more success, and not being sure what success looks like yet. Infrequent users (N=5) report improved connections resulting in more success, having success with their audiences, not having any effects yet, or not being sure if it had affected their success (see Table 23 for detail).

Table 23

Changes in Perception of Success by User Group

Responses By User Group	Count
Highly Active Users (*N*=5)	
Improved connections meaning more success	3
Expanding into social media	1
More community focused success	1
Personal growth and use of collaborative space	1
Average Users (*N*=5)	
Not sure what success looks like yet	3
Personal growth and use of collaborative space	2
Sharing ideas	1
Improved connections meaning more success	1
Infrequent Users (*N*=5)	
Not yet, not sure	4
Improved connections meaning more success	1
Success is with our audiences	1

Value the Online Community Adds to the Organization and its Members

While value for the individual community members is important, equally important is the value the online workspace adds to the organization as the sponsor and facilitator of the workspace. Facilitating organization members were asked what value the online workspace has added to the Earth Science community and E/PO

efforts. Members responded that, “I think the Toolkits/toolboxes being developed will morph into a clearinghouse of resources that new E/PO folks can utilize in their jobs” and “I think it has been a good start towards creating a viable workspace for community members. It's a valuable tool for getting the word out about projects and for storing information in an easily accessible location. The only drawback has been getting community members to utilize the site. It would be a very powerful tool if more people would participate.” The 2 other responding members reported similar feelings that more participation is needed to continue to develop the workspace and shared assumptions about how the value would increase over time as it becomes a richer resource.

Community members were asked to rate the short and long term value of the online workspace on a variety of parameters. In all areas, community members rated the long term value higher than the short term value. Community member rated the short term value of collaboration efforts between E/PO professionals in the forum as 4.0 and as 4.4 for the long term value (significantly higher long term value than sort with a p value of 0.02), getting the word out about their E/PO project 4.1 short and 4.6 long (p value of 0.03), and communicating with other members 4.0 short and 4.3 long (p value of 0.03). Table 24 shows the average ratings on a scale of 1-5 for short and long term value, and the t-test value from comparing them. Note that for the last three areas, the long term benefit is rated significantly higher than the short term value.

Table 24

Community Member Ratings of the Short Term and Long Term Value of the Workspace (scale from 1-5 with 1 being no value and 5 being a very high value; N=22)

	Short term means	Long term means	t-test sig
Your own work as an E/PO professional	4.2	4.5	0.23
Your knowledge of Earth Science issues and ideas	3.6	3.9	0.21
Your knowledge of Earth Science community events and news	4.5	4.6	0.54
Your knowledge of Forum events and news	4.5	4.6	0.82
The Earth Science community's work as a whole	4.3	4.7	0.11
Collaboration efforts between E/PO professionals in the forum	4.0	4.4	0.02
Getting the word out about my E/PO project	4.1	4.6	0.03
Communicate with other members	4.0	4.3	0.03

Results were mixed when asking community members about valuable knowledge development. When asked if participation in the online workspace had helped to further develop their knowledge and expertise, 50% of 22 community members responded that it had and 45% responded that it had not (1 community member did not answer this item). When asked to explain their response, those

members that said it had helped further develop their knowledge and expertise noted that the workspace, "Has furthered knowledge of work within the forum and events sponsored/facilitated by the forum," that, "There is a growing body of knowledge in the tool/site," that they had, "Learned about many other resources," and that, "By reading what else is going on in the forum, I'm broadening my horizons." Those members that reported that it had not helped further develop their knowledge and expertise noted that they had not participated in the workspace much, that email works fine, and "I simply have not used it for that purpose. My purpose to date has been to contribute to the K12 working group projects and discussions."

Level of Belonging Felt by the Online Community Members

Feelings of belonging make a community of practice more valuable to the members so this issue was probed further in terms of the value issue. To help establish what the level of belonging was felt by community members, questions were asked of members about their sense of belonging, factors limiting their participation, and their willingness to continue to participate. When community members were asked whether participation in the online workspace made them feel more like they belonged to this community of educators, 64% responded that it had and 32% responded that it had not. When asked to explain their response, members reported that, "Theoretically, everyone is there," that, "I now know more about who else is in this community," and "The fact that the workspace exists tells me the heads of NASA EPO are interested in building a community." Those that reported it had not helped to establish a sense of belonging said they were "new" to the workspace, had

not had the time to participate and felt there, "Is not much discussion in the workspace."

Kernel analysis of the open-ended explanations from community members of how participation was affecting their sense of belonging shows that the largest percentage reported that participation had helped them feel more like they belonged to the community (44%). They said they were learning more about the people and projects of the community though the use of the workspace. Others reported a sense of belonging because of the resources (25%) and that it is a good exchange mechanism (13%). Those that felt that participation had not made them feel more like they belonged said that it had not yet or that they were new (57%), that they don't feel there is a sense of community on the workspace (29%), and that there is limited discussion in the workspace (14%). Table 25 shows the key ideas for those responding yes, and those responding no.

Table 25

The Role of the Online Workspace in Creating Feelings of Belonging to the Community

Explanations given for those who did see that the online response increased a sense of community (*N*=8)	**% of Responses***
Learning more about the people/projects	44%
Resources	25%

(Continued)

Explanations given for those who did see that the online response increased a sense of community (*N*=8)	% of Responses*
Good exchange mechanism	13%
Concept is great and could be amazing	6.3%
Everyone is there	6.3%
Reading discussion posts	6.3%
Yes Response Total	100%
Hasn't yet/new	57%
Don't feel there is a community on the workspace	29%
Limited discussion about workspace	14%
No Response Total	100%

When asked what they felt were the limiting factors to their participation, a few community members listed social components of the workspace as limiting factors: no live chat function (14%) and can't search people by expertise (9.1%). The majority of community members were willing or very willing (67% rated a 4 or 5 on a scale form 1 to 5) to continue to participate in the online workspace. The remaining 33% rated their willingness at a 3 on the same scale. No community members indicated that they were not willing to continue to participate. When asked to explain their rating, those that rated their willingness at a 3 reported having trouble with the navigation of the site, while those rating it a 4 or 5 had few complaints other than finding the time to participate more.

Kernel analysis open-ended responses explaining their ratings reveals those that rated their willingness to continue to participate the lowest (3 on a scale from 1 to 5 with 5 being the highest) saw limited benefit for them (38%), have limited time (25%), have navigation issues (25%), or are required to use it for work (13%). For those community members that rated their willingness to continue to participate as a 4 or 5/5 explained they felt it was getting better/important for the future (41%), had important information/interactions (24%), that value for them equaled future use (24%), and that it was easy to find what they needed (12%). One member recommended, "In March, 2011, I was new to my position and overwhelmed with learning new procedures/expectations. I simply saw the workspace as one more level of input (and another login to remember!) in an already overloaded intake of info. Now I have been personally solicited to work on projects that necessitate the use of the site. With that involvement comes a level of comfort- as well as a sense of community- that only comes with repeated and purposeful use." Another member commented, "The workspace is critical for the success of working groups and task forces -- it's our place to develop ideas... just hard to get folks moving..."

During the interviews of community members, they offered ideas about improving the online workspace to make it better the community. They suggested moving things to an archive area more quickly limiting the clutter starting to emerge on the site, having strands within the discussion area to help organize the many discussions, and making the front page more important by adding meeting updates, a master calendar, and community news. These suggestions suggest an interest in the success of the workspace and a commitment to using it going forward. Table 26

presents the analyzed open responses from community members describing their willingness to continue to participate in the online workspace.

Table 26

Explanations about Community Members' Willingness to Continue to Participate in the Online Workspace

Key Phrase or Idea	%
Ratings of 4 and 5 Explained	
Getting better/important for the future	41%
Important information/interactions	24%
Value = use	24
Easy to find what is needed	12
Rating of 3 Explained	
Limited benefit	38%
Limited time	25%
Navigation issues	25%
Required to use it for work	13%

Effectiveness and Sustainability of the Online Community

Communities of practice often have natural life cycles, growing out of need, maturing, and evolving as needs and interests of the community members change. For the facilitating organization, sustainability becomes an issue. Community members were asked on the Community Member Survey (N=22) to rate their level of interest in the online workspace when it first opened (August 2010), half way through (March 2011), and at the time of the survey (January, 2012). Rating their level of interest on a

scale from 1- 5 with 5 being the highest, community members first rated the online workspace (August, 2010) with a mean of 2.8, a mean of 2.9 for March, 2011, and 3.7 for January, 2012. There is a significant difference between the January 2012 member ratings when compared to both the August 2010 and March 2011 ratings ($p = <0.01$ for both comparisons) for all users. Highly active users mean rating of interest began at 3.5, fell slightly to 3.2 in March, and rose to 4.2 in January. Average users mean rating of interest began at 2.6, was 3.1 in March, and rose to 3.9 in January. Infrequent users rating of interest changed the least of the three groups beginning at 2.6, remaining unchanged for March at 2.6, and finishing at 3.2 in January. Table 27 shows the means for each point in time by user activity group and for all users. Figure 7 shows the frequency of responses for each rating (1-5) for the three points in time.

Table 27

Community Member's Level of Interest in the Workspace Over Time (scale from 1-5 where 5 is the highest)

	Mean Response (1-5 scale)			
Time Points	**Highly Active Users (*N*=5)**	**Average Users (*N*=8)**	**Infrequent Users (*N*=9)**	**All Users (*N*=22)**
When first opened – August 2010	3.5	2.6	2.6	2.8
Half way through – March 2011	3.2	3.1	2.6	2.9
Now – January 2012	4.2	3.9	3.2	3.7*

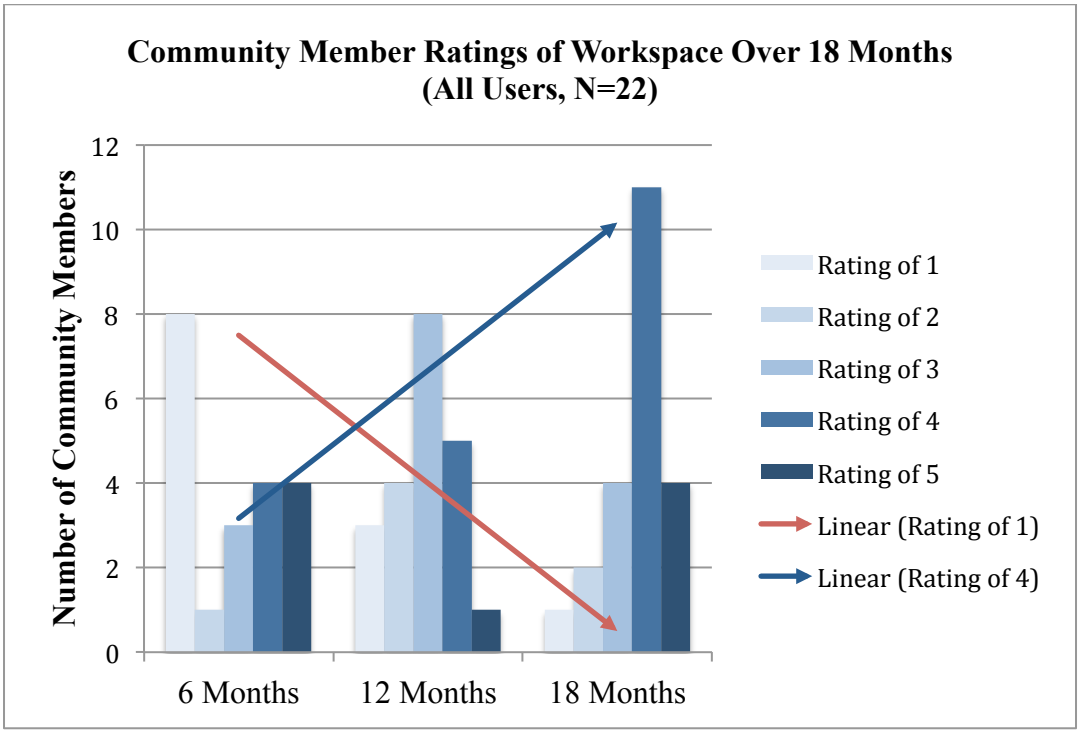

Figure 7. Community member ratings of workspace over 18 months (*N*=22)

To be sustainable, community members must be able to work together collaboratively in meaningful and valuable ways, like solving problems. When asked on the Community Member Survey whether they were able to solve a problem working with a colleague through engagement in the online workspace, all community members responded that they had not (100%). When asked to explain their response, members indicated that they had not posed any problems to be solved, that they were new and had not participated long enough, that they haven't tried, or that they would prefer to use the phone and email.

Steps Taken to Promote Sociability Within the Online Community

Social interactions can contribute to the success of a community of practice. To determine the level of sociability within the workspace, community members were

asked what they felt the purpose of the workspace was and if they felt the Earth Forum encouraged their participation. Two of the choices for community members were "Increase sociability among forum members" and "Provide a space to interact with other E/POs." Eight (36%) of the responding community members indicated they felt a purpose of the online workspace was to increase sociability; 72% felt the purpose was to provide a space for them to interact with other E/POs.

It may be that with increased interactions comes more of a social experience for participants. Simply getting together more may lead to better relations translating into an enhanced interaction. When asked if they felt the Earth Forum encouraged their participation in the workspace, 82% of responding community members felt that it was encouraging them; 18% felt that is was not.

Part 3 Summary: Facilitating Value Within a Community of Practice

Facilitating value can support participation in a community of practice. Data about value was collected by surveying and interviewing community members about their experiences in the online workspace. Highly active users found the collaborations with their teams to be of value by improving products and facilitating discussions. When asked if their participation had contributed to the success of the larger community, the highly active users all felt that it had while fewer average users and no infrequent users felt it had. There were differences in perceptions of success related to member participation with highly active users reporting improved connections that lead to success and average and infrequent users reporting mixed results about their success. Facilitating members report that there is value for the organization as well as the members. Members report feeling that the organization

values their participation in the workspace because of their investment in it. While participation varies among community members and seems to be a factor in knowledge building and value, interest continues to increase among members in the workspace and suggests a continued increase in value over time.

Chapter Summary

In this chapter, the data presented were collected from four sources, a survey of community members participating in the online workspace (*N*=22), a survey of the facilitators of the online workspace (*N*=5), interviews of 15 of the community members who completed the community member survey, and metrics of community member participation in the online workspace. The chapter was organized around the three focus areas: (a) Activities and Interactions, (b) Knowledge Building and Interactions, and (c) Facilitating Value.

For Activities and Interactions results show that time and navigation of the workspace were the most significant limiting factors in member participation. While barriers may exist to participation, all community members reported that they were willing to continue to participate. Participation seems to promote feelings of belonging to the community and these feelings grow as members engage more in the workspace. Responses were mixed as to whether participation had helped to further develop their knowledge and expertise. Those that were most active in the workspace reported working in new ways, collaborating with colleagues, and adding and sharing information and knowledge.

For Knowledge Building and Interactions results show that for highly active users, interacting with others in the online workspace helped produce community

resources, documents, and new ideas. Workspace resources were used in collaborative efforts, to exchange forum specific information, and to help shape practice by highly active users while resources were less impactful for average and limited users. While a majority of community members reported feeling the workspace was designed to promote knowledge building, no members reported it had helped them solve a problem with another colleague. Community members were most active in sharing resources and collaborating with colleagues. A large majority of community members reported that they felt the purpose of the online workspace was to provide a space for them to interact, provide an archive for forum information and activities, and provide current news, events, and data calls from headquarters.

For Facilitation of Value, results show that for highly active users their success has been affected by their ability to coordinate and collaborate with others while facilitating discussions, and that these have resulted in improved products and outcomes. Participation in the online workspace seems to have contributed to the success of the forum through helping others and improving work quality and efficiency. Changes in the perception of success seem to have begun to develop for the most highly active users as they reported improved connections, more community focused success, and personal growth. From the facilitators' perspective, the hardest thing has been getting forum members to participate in the online workspace, a necessary step to continue to grow the workspace and enhance its value. The long-term value of the workspace was rated significantly higher in terms of collaboration efforts, sharing information, and communicating with others. Participation in the online workspace seems to be playing a role in the sense of belonging to a community

of educators for participants by helping them learn more about other community members and projects they were working on. Lastly, community members rated their level of interest in the workspace significantly higher after a year of use than at either the beginning or after 6 months of use.

Underlying the changes described in the community and their engagement and interactions in the online workspace is the active facilitation efforts of the facilitation team. Simply building an online workspace was not enough to ensure utilization by the community. Deliberate steps including requiring members to engage in the workspace as part of their job requirements, posting documents in the workspace an not sending them out via email, listing important news and events on the workspace homepage, and promoting social interactions by highlighting personal achievements and profiles were taken to insure member engagement. Increases in member engagement over time are likely, as least in part, to be associated with the efforts of the facilitating team and are of critical importance to the successes, knowledge building and value creation for the community.

Chapter 5. Discussion and Conclusions

Introduction

Co-located communities of practice have been found to contribute value to organizations, help promote project success, and play important roles in knowledge management (Wenger, 1998a; 2000; Wenger et al., 2002). Some of these same successes have been shown to hold true for virtual communities of practice (Dube et al., 2002; Hara & Hew, 2007; Wenger et al., 2009) where combining both the traditional co-located community with the emerging distributed virtual community may enhance practice (Johnson, 2001; Kimble et al., 2001). Wenger (2004) describes how groups work together directly, through meeting face-to-face and indirectly, through virtual meetings, and being brought together by the communities need to grow their knowledge and be part of a community of like-minded people. Through their interactions they shared information, experiences, insight, and advice.

This research adds to the growing body of knowledge about the impact of online workspaces in the development of communities of practice. More specifically, this research examined the impact of the addition of an online workspace on an existing community of practice. The data suggested that members were engaged within the online workspace, that they shared information, built knowledge and resources, and connected with others. Those who are more active benefited more from the workspace and those who were not found the workspace difficult to navigate and time consuming. However, those who are used the workspace less often are transitioning, in some cases, to utilize it more frequently and should therefore begin to share similar benefits as those already using it often and effectively.

Interpretation of Findings

The findings interpreted here are derived from the systematic analysis of the data from the previous chapter including the online workspace metrics, the community member survey, the facilitating member survey and the community member interviews. In this chapter, the data from each of these sources is interpreted and discussed as part of the continued attempt to gain deeper understanding of the impact of the online workspace on the greater community of practice. The interpretation is organized by research question. In addition, this research is placed into the larger context of research on communities of practice and online communities of practice while recommendations for future research are presented.

The purpose of this study was to examine the role of an online workspace component and how participation in this workspace supports the work of an established community of practice. In traditional communities of practice the members are meeting face-to-face while living in the same community forming a co-located group. For the Earth Forum Education and Public Outreach community, while they have been meeting face-to-face at annual retreats, meetings of opportunities, and at other work related activities for many years, they have more recently begun meeting virtually through the online workspace.

The development of the online workspace comes as NASA's Science Mission Directorate Earth Science Education and Public Outreach Forum looks for new ways to effectively connect Education and Public Outreach personnel with each other and the information they need to enhance their work efforts. The forum holds a yearly retreat where personnel present their most current education and outreach efforts in

"share-a-thons," interact with other educators, hear presentations from community members and leaders in the field, gather in smaller groups to address specific issues and needs, and network. Forum personnel also meet during "meetings of opportunity" held at different national and regional conferences where they have the chance to hear from NASA headquarters about changes in NASA education as well as interact with each other in meaningful ways. The community workspace was designed to continue these types of interactions for the community as a whole and allow forum members the opportunity to share and learn from one another, co-develop knowledge, and advance their practice. To help determine whether the introduction of the online workspace component had this affect on the forum community, all collected data was evaluated and summarized.

To help organize the conclusions of the data in this chapter, the Exploratory Data Matrix will be utilized as a summarizing structure presented at the beginning of each section. The matrix offers an opportunity to look at how each of the three components of the community of practice (role and activities, knowledge, and value) have changed, if at all, with the introduction of the online workspace component. Beginning with "prior," the matrix helps organize an exploration of the changing nature of roles and activities, knowledge, and value as community members utilize the online workspace. "Improved" represents things that were done as part of the traditional CoP and now done in an improved manner as a result of having the online workspace. "New" roles and activities, knowledge, and values that have developed as a result of working within the online workspace represent what may change with the introduction of an online workspace. Additionally, it is at the intersection of these

different ways of doing – prior, improved, new – that changes in practice may be observed.

Table 28

Exploratory Data Matrix

Prior	Improved	New
Transitions	Transitions	

The Shifts in Roles and Activities in a Community of Practice when Adding an Online Workspace Component

When we look at changes in the way in which member of the community interact with one another we see that there have been both improvements from the past and the beginnings of new practices that were not possible before the introduction of the online workspace.

In the past, coordination of activities took place over email and telephones. While these activities were meeting the needs of basic communication and collaboration, their limitations became clear with the introduction of the online workspace. Initially, participation in the online workspace was limited but it did increase over time. Participation in the online workspace produced greater collaboration, working groups for projects, and the workspace emerged as a central location for community information and resources. New behaviors also emerged with increased participation in the workspace including virtual working groups, regular

participation, and the workspace emerging as community members main source of interaction with the community.

Table 29

Changes in Workspace Role/Activities

Prior	Improved	New
• Workspace is new – limited participation • Email – for sharing print information • Teleconference calls for group sharing over distances • Phone calls to coordinate and share information • Phone book used for connection information	• Increased participation over time • Place for greater collaboration • Online working groups • Central location for information and resources • Community member profiles for connection information • Over time, community members are engaging with the workspace • Management promoting participation	• Participation as regular practice – new normal • Virtual working groups • Some community members are logging into the workspace daily or using the workspace as their homepage
Transition – Workspace as central location for information	Transition – Recognition of workspace as a more efficient means of collaboration between disperse community members. Workspace is emerging as central location for activity.	

Recognizing that there were shifts in the activities of community members based on their level of participation in the online workspace, we need to consider what these new activities mean for this community and online communities in general. First, members that have become "regulars" are reporting the greatest benefits. For this group, participation has become habit. They have transitioned to utilize the workspace as the central locations for information. So, what has driven them to participate regularly and what role does facilitation play in supporting this? The highly active user group found a need or value early in the life of the online workspace and so adopted practices that would enable efficient use and interaction with other members. They say that the workspace afforded them a more efficient means of collaboration. Being given specific tasks also seems to have played a significant role in this adoption. Facilitation in these instances took the form of job requirements. When given the specific task of collaborating with a working group by way of the online workspace, their participation was almost certain. While it is true that not all community members collaborating with their working group participated regularly in the online workspace, most did and this played a significant role in their activities.

Second, there may be a new sense of what working together entails. When community members are meeting face-to-face in a traditional sense, they are physically together or co-located (Boetcher et al., 2002). Perhaps regular online participation may lead to a new level of comfort for those more familiar with co-located ways of interacting. In an online community of practice, being "together" by sharing a common workspace may offer similar benefits to physical togetherness,

traditional co-location. Community members that have been together for long periods of time and had consistent and meaningful interactions speak of their community members in similar ways to their colleagues that have worked with others in more traditional fashions (Mieszkowski, 2000). Working in an online workspace such as this, community members may be developing the same types of relationships that their traditionally co-located colleagues share. Similar to when we say we "talked" with someone, it is understood to be the same whether in person or over the phone. As time goes by and interactions persist, it is possible that the lines between co-located and distance interactions will continue to blur and morph into a new sense of what working "together" and "with others" means.

The introduction of the online workspace produced both new and improved ways of working for community members. Where once community members were limited to phone calls and email to communicate and collaborate with other members of the community, with the introduction of the online workspace, members had a new means through which they could interact with each other. These new interactions developed into virtual collaborations between members, increased interactions and information sharing, and participation in the online workspace emerging as the new normal way to interact replacing emails and phone calls.

Knowledge Building Within the Online Workspace

Distributed communities still benefit from interactions, the exchange of ideas and experiences, and the collective building of knowledge about their practice (Lima et al., 2007). It was a specific intent of the facilitating team to promote interaction between community members for the purpose of knowledge building. Community

members were encouraged to collaborate and utilize the workspace to do so, interact regularly, and see the workspace as the priority of the Earth Science Forum. When interview participants were asked to describe a specific resource that an activity produced, high active users report producing community resources, documents, new ideas, and a feeling of community.

In the past, documents exchanges and information exchange occurred primarily through email. With the introduction of the online workspace, it became the central location for document posting and exchange, posting community news, and connecting all community members with a central location for information. What emerged as users utilized the online workspace was the co-creation of documents, members adding information about their projects, and new information being developed collectively within the workspace and shared their with the entire community.

Table 30

Changes in Knowledge Building

Prior	Improved	New
• Document exchange • Email updates • Community announcements via email	• Document sharing • Daily and weekly news and information updates on homepage	• Co-creation of documents • Members adding announcements, news, and project updates • New documents created belonging to the community
Transition – Online workspace as a more efficient means to locate important information – central repository of community information		Transition – Seeing the workspace as a collaborative environment for construction of knowledge together

Community members are learning and exchanging knowledge as a result of their purposeful interactions (Bielaczyc & Collins, 1999) and producing new cognitive artifacts (Bereiter, 2002) as a result of participating in the online workspace. Average users report awareness, documents, feedback, and ideas and information being produced. Infrequent users report documents, profiles, awareness, or nothing being produced. With highly active and average users, we see more engaged and varied activities when comparing them to infrequent users who are primarily

accessing profiles and documents. These activities can consist of collaborative efforts and hold particular importance because they are solving authentic problems (Wick, 2000). Interviewed participants were also asked to tell how they were using these resources. Highly active users talked about collaboration efforts, alignment with the organization and reshaping practice. Average users talked about having more work flexibility and making others thinking and ideas apparent while infrequent users were either not sure or felt they were able to align with the other community members and share their materials outside of the community.

Most of the responding community members reported that the purpose of the online workspace was knowledge building. Members also reported feeling that the professional development opportunities, community news and announcements, file sharing and posting of documents were all contributing to knowledge sharing. A large percentage of community members reported that they offered knowledge or expertise through the online workspace gained skills, shared resources, and collaborated with a colleague, all examples of knowledge building. While some of these members had only participated a few times, they were active in different ways. When asked if participation in the online workspace had helped to further develop their knowledge and expertise, the responses were split with half of community members responded that it had and a bit less then have responded that it had not (one community member did not answer this item).

Interactions are also occurring within the online workspace that play a role in member participation and knowledge development. Primarily, community members felt the online workspace provided a space for them to interact with other members

while many others felt it provided an archive of forum information and activities and current news, events, and data calls form headquarters. These are both part of the purposeful design and facilitation efforts of the facilitating team. During the interviews, highly active users reported many interactions with other members that utilized the workspace such as collaborative efforts in their working groups, the sharing of information and documents, and connecting with others. The regular announcements and community news that is posted on the workspace homepage, seems to also be driving traffic to the site as members are finding it a valuable resources.

One of the greatest barriers to workspace utilization seems to be site navigation. Looking at the results from both the surveys and interviews, a pattern emerges where the more community members are using the site, the more frustrated they are with getting around and findings the things they need. When asked to rate the usefulness of the workspace, community members reported a mean response of 3.4. So, although they may at first find the navigation challenging and have difficulty finding time to commit to using the workspace, once they do so, they are finding it easier to find what they are searching for and that it has more value for them.

Knowledge sharing and building in a community of practice is the result of meaningful and purposeful interactions between community members. When engaged in an online workspace or virtual community, members are still actively sharing knowledge. This is the nature of their engagement. When members are sharing information electronically, does this change the nature of the information exchanged? Findings from this research suggest that the nature of the information exchanged has

not changed. Documents are still being shared, information is being exchanged, and work is being done. What is improved about these efforts is the efficiency they are accomplished. With continued use, new behaviors have emerged where community members are co-creating resources within the workspace, members adding their own announcements and news, and documents that are created collaboratively within the workspace are perceived as belonging to the community itself and not a specific project or individual. What community members are exchanging is still critical information and knowledge with the purpose of further developing the expertise of the greater community. This was traditionally what community members were attempting to do when interacting in co-located situations.

Knowledge sharing and building in the online community has become more efficient as members no longer need to coordinate synchronous interactions. Replacing them are asynchronous interactions that allow for exchange in time and space that is more convenient for the individual and beneficial to both the individual and the community simultaneously. In essence, working in a virtual community, members are freed of constraints normally felt by people working across time zones and schedules. Products that were produced were done so by these types of interactions where versions were developed and worked on, vetted over time and through an iterative process of refinement, and released to the community for comment and use.

Documents, created and disseminated in this way, were not static. Where traditionally, documents were created in committee, refined, vetted, and shared, utilizing this new medium for interactions, documents generated through interactions

within the workspace are working, living, knowledge capital. Any community member can download a particular document and adjust it fit their particular situation and needs. The ability to individually customize the available knowledge to fit their particular needs represents an important change in the way knowledge is utilized by the community. In this way, the co-created knowledge existing in the form of a particular document, can be evaluated individually and adjusted accordingly. This democratic exchange and utilization may also have implications for the evaluation of quality and how it is handled in the community.

What is still unknown is to what extent the most active users are also producing knowledge. Are the most active users the greatest knowledge producers or are they highly active in benefiting from the knowledge produced by others? There is evidence suggesting that those that are the most active in the online workspace are also the producers of knowledge but as it was not directly measured it is not completely clear. Those that are producing knowledge may have also been those that were the leaders of the community prior to the introduction of the online component.

Knowledge building has been enhanced through the utilization of the online workspace. Community members, as they become more active, are improving their interactions with each other, sharing information more freely, and getting information more effectively. They are also developing new ways of developing knowledge including co-creating documents and resources within the community and sharing them as community resources. They are also adding their own information and announcements about their projects and looking to connect with others facing similar challenges. Through the utilization of the online workspace, community members

have increased their information sharing, resource development, and ability to address and solve problems they face.

Value Created by the Online Workspace

It is necessary to look at value from multiple perspectives and through different measures. Like co-located communities, virtual communities of practice integrate the community and lend legitimacy, influence, and value to community members (Wenger et al., 2002). Value for community member may come in a variety of ways. For some, relationships are the primary value gained from participation in online communities. For others, value only comes form direct increases in work productivity. Then there is the value for the organization itself. Prior to the workspace, collaboration with colleagues was valued but little opportunity existed to do so. With the introduction of the online workspace, community members could increase their collaborations, make time to participate with others, and develop new ways of interacting that enhanced their and their colleagues work ultimately lending value to their work and the greater work of the organization.

Table 31

Changes in Value

Prior	Improved	New
• Collaboration with colleagues is valued • Online space are viewed by some as having limited value, because of learning curve and time limitations	• Increased collaboration through workspace • Making time to participate	• Workspace supports new forms of collaborative efforts • Workspace is emerging to be a critical component extending the opportunities for community exchanges • New forms of evaluation of quality are likely to emerge as the community deals with continually evolving documents rather than finished and validated documents
Transition – Community members using the workspace as part of their "job" and responsibilities	Transition – Workspace is emerging as the primary location to collaborate with distributed community members	

When interview participants were asked to describe how the resources developed and used from and within the workspace affected their success, highly active users reported greater coordinating with their team and improved products and outcomes. Average users reported improved productivity and simplified contributions but not great collaboration or improved products. Most infrequent users reported that they had not affected their success. Interview participants were also asked whether their participation contributed to the success of the Earth Forum Community. All of the highly active users reported that it had (100%) followed by 60% of the average users and none (0%) of the infrequent users suggesting that participation was more impactful for high users. When asked to share stories of success, highly active users talked about how participation had improved their connections and that this had lead to greater success while most average and infrequent users were not sure yet what success would look like.

When asked about the value of the workspace, community members suggested that the value was emerging and developing and that in the long term it was significantly more likely to help them collaborate with other members of the forum, get the word out about their project, and communicate with other community members. Additionally, participation has helped members develop a greater sense of belonging to the community which should grow as members utilize the workspace more frequently. Members report feeling encouraged to participate and participation may promote a sense of community (Mieszkowski, 2000).

Members recognize that there is value in the online workspace component of their community of practice, they have begun to increasingly feel that they belong to the

community, their level of interest has grown significantly, and they feel it is a place for them to interact with other members of their community. The value perceived by the members translates to value for the organization.

Once the workspace was launched, the facilitating organization began to encourage the utilization of the workspace by posting announcements there, listing personal profiles, uploading critical documents, etc. Community members reported through the survey and interviews that these efforts directly influenced their use of the workspace. Because of this, community members reported that they had made working with the others through the workspace a priority and had made time to participate. Over time and because of increased commitment to using the workspace, members reported new ways of working and interacting. While it may not be completely visible from the data that assimilation of new ways of working and interacting have proceeded accommodation, it is believed that based on Piagetian learning theory that this is the process occurring here. Highly active members have the new behaviors of collaboration, exchanges of information, and feelings of ownership of information followed by seeing their efforts in a new light.

Working in a new way, utilizing the online workspace, seems to have value for the members of this community and the organization. The online workspace has enabled members to build relationships with other members that previously they were not able to because of the physical separation and limited interactions. Through the online workspace members were able to work in working groups comprised of members form different NASA centers that are widely geographically dispersed. So, working in this new way, the value for some was the fostering of new relationships

with community members. As community members have begun to be more engaged with the online workspace and increased their collaboration with colleagues, there have been gains for the organization as well including streamlining information dissemination and in member output due to increased opportunity and connectedness.

For others, being able to work in small incremental ways was valuable. Members may not have the opportunity to be part of a formal working group but having the change to see what is being developed and offer expertise where appropriate means they are able to contribute to the success of the group. Their input does not need to be formally invited. By being part of the online workspace and so, part of the community of practice, they have the opportunity to be involved without being intrusive to the workings of others. They do not need to call the group leader or offer their suggests in writing. They can simply post a comment to the group from within the workspace, giving the working group the opportunity to review their comment at a time and in such a way that is most valuable to them. Working without disruption has been very beneficial. Lastly, for the organization, having community members working in efficient ways, developing content collaboratively, and housing information in a central location was valuable. For the organization, there is considerable investment in the success of the online workspace and seeing the knowledge developed and meaningful interactions occurring has significant value.

Ultimately, individuals, groups, and the organization determine value for themselves. Each has their own idea of what is valuable and what it looks like within the online workspace or their particular viewpoint. Consistently, community members making use of the workspace reported a growing value to their work and of a personal

value resulting from their participation in the online workspace. For virtual communities of practice in general, mindfulness of value production needs to be at the forefront when designing and facilitating the community. Questions to consider would be what value looks like to the different stakeholders, what measures will be used to assess value, and who will be determining what the value is. The reputation of the community is linked the products and making it vital to safeguard the community's reputation by properly evaluating the quality of products being made available to others. The democratization of information that the community makes possible comes with inherent risks as to the information's quality. While some aspects of the community may not easily be changed, documents available to all users can be refined and utilized with little or no input from the larger community. Properly vetting what is presented as the "knowledge" of the community through documents becomes a challenge associated with greater freedom to interact, collaborate, and produce.

During the interviews, community members were also given the freedom to expand on any responses they wished. Often, this resulted in stories with greater detail and additional context. One such story from a highly active user revealed a major change in behavior associated with the utilization of the workspace. She described herself as a engaged but not very vocal member of the community, often feeling dominated by other community members during face-to-face meetings and not able to share here ideas in any meaningful way. She described the workspace as a place where she was able to share her ideas and have them heard and appreciated by others. She describes becoming a highly active user in the workspace after

participating in a small working group and posting a few things to a discussion board. Later, her ideas were highlighted and incorporated. This helped her feel empowered and greatly increased her engagement with the community. Another of the highly active users of the workspace revealed themselves to be a fairly non-active member of the community as a whole. When asked to talk more about their changed engagement, they described working within a collaborative groups through the workspace and how they had a positive experience, ultimately feeling that what was produced was of high quality and incorporated input from all team members.

Value, when measured by either the individual community member's perspective or form the organization's perspective, was enhanced by the development and utilization of the online workspace. For community members, they were encouraged to participate and so begun to make time do to so. As they participated more frequently they found value in the increased collaboration with other members, and began to see the workspace as a place to post information about their own projects and look for additional ways to collaborate with other community members. The workspace also proved valuable for the organization in increased participation in interaction of the members and the production of resources shared with the community.

Conclusions

It seems clear that the online workspace component of the Earth Science Education and Outreach Forum plays an important and emerging role for this community, that it supports knowledge building and knowledge sharing, and that it has growing value for those that are utilizing it. With increased participation or

"usage" comes increased value to the participant. The online workspace has become a place for members to gather, to connect with, and to get to know each other better (Boetcher et al., 2002). These fuctions are in addition to performing important forum related activities. Organizations have reported an increased use of online groups as part of their organizational plan for success (Glassop, 2002) and have cited them as a reason for increased successes with employee commitment and customer satisfaction (Overholt, 2004; Wisner & Feist, 2001). They have also found that decision-making is more effective when done collaboratively (Katzenbac & Smith, 1994). Supporting these group efforts with an online community has increased the community's effectiveness (Hoadley & Kilner, 2003). NASA is among the growing number of organizations looking to explore the potential of online communities.

Overall, the online workspace component has been effective in enhancing the interactions, connectedness, and knowledge building for the forum while not everyone. Those that were limitedly engaged with the community before with introduction of the workspace found the workspace as a way for them to interact and participate in a much more meaningful way and being designated as "highly active users" of the workspace. This new level of interacting was apparent in at least two of the most highly active users of the workspace and to a lesser extent in a few of the average users. These stories of engagement are of particular interest. While not captured explicitly as part of this research, they offer a more detailed and nuanced glimpse of how community members are interacting with the online workspace and each other as a result.

There remains a sizeable portion of the community that is not utilizing the workspace and so they are not sharing in the benefits listed. Their limited time and perception of not finding what they need in the workspace contributes to their behavior. This represents a dilemma as to how to best engage these forum members. If changes to the navigation process suggest that the system is easier to use, they may make the time to explore. Once they begin to have success, it is likely that the more time online will provide enough value to keep them returning to the site. However, as long as they are not engaging with the workspace, it will remain difficult for them and will limit their ability to effectively work with others in constructive ways that benefit them and their community.

Recommendations

Recommendations are divided into two areas. First, recommendations are given for the Earth Science Education and Public Outreach online community workspace. Second, recommendations are given for online communities of practice. Recommendations for the Earth Forum online workspace are derived from what was learned from the data collected and analyzed and are forum specific. Recommendations for online communities of practice are also derived from the data and analysis of this research but are generalized for a broader audience.

Earth Forum Specific Recommendations

Based on the findings of this report, a series of recommendations are proposed as part of the ongoing efforts to improve the online workspace component of the Earth Forum Education and Public Outreach community.

1. Develop strategies to engage infrequent users in the online workspace

- Offer navigation training sessions at meetings of opportunity throughout the year and as part of continued professional development opportunities.
- Develop a mentoring program that connects high users with low users in a near-pear setting.
- Continue to promote the online workspace as a valuable tool for collaborative efforts – perhaps with stories of success from other users.
- Look to improve the navigability of the online workspace itself from comments and suggestions from users of all levels.

2. Promote stories of success
    - Enhance the sharing of success stories from community members as part of the ongoing efforts to promote the workspace.
    - Should be used as part of a comprehensive plan to continue to promote social interactions within the online workspace.
3. Continue facilitation efforts
    - Facilitation efforts continue to play an important role in the success of the online workspace. Announcements, news, and articles are an important part of many users' reason for participating.
    - Promote leadership from within. Turn over some facilitation/leadership functions to community members themselves where possible.

Virtual Community Recommendations

1. Usage
    - The greater the community member participation, they greater benefits for members and the community as a whole. Therefore, encouragement and facilitation of member participation is critical.
    - Online community space needs to be easily to navigate , with intuitive choices that create a low learning curve for new users.
2. Knowledge Building
    - To facilitate the building of knowledge within the online community, it may be necessary to encourage use and participation through task assignment. Work related activities may be the catalyst that engages them in future activities within the online community.
    - As in traditionally co-located communities of practice, members need to have opportunities to come together and share in meaningful ways. Utilizing online communities, the constraints of time and space can be lessoned allowing for greater interaction and sharing.
3. Value
    - Value is different for different stakeholders. Community members may be looking for social value from their participation, work productivity, organizational contributions, or a combination of these. They may also have different needs and perceived values at different times during their membership. Online communities need to be versatile in their design and

flexible enough for users to find meaning and develop value for themselves through their engagement.

Suggestions for Future Research

A number of different research possibilities emerged while working with the online workspace. The workspace has emerged as a developing value for the forum community, their work, and for NASA as a knowledge organization. However, there are some important design changes to consider along with possible future research.

Experimental Design Changes

A controlled study is always the preferred experimental design. To have one group participating in the online workspace while a second, similarly positioned group continued their efforts along traditional lines may help us determine to extent to which the online workspace affected community members. However, this is a rather impractical approach and one that seems unnecessary. A better design change would be to track individual participation over time within the online workspace. This would allow for a very detailed analysis of individual participation and patterns of participation could be identified from the data. Community member participation could be tied to particular needs or interests and these might be made visible from this sort of data. Participation is likely to fluctuate on a daily, weekly, and monthly basis as well and patterns here might be helpful in designing better facilitation efforts.

The Earth Science Education and Public Outreach Forum is a large community comprised of members from varied backgrounds. It is likely that member jobs and interests drive participation in the workspace as well. This research does not shed light on any different subgroups that may be participating more than others. It

would be of great interest, for instance, to determine if communication specialists were using the workspace more or less than those focused on educational product design or media specialists. Perhaps the online workspace has a particular value for one group more than another.

Possible future research

A number of different possibilities exist for future research on this community and online communities in general. While they are focused on this online workspace, their ideas may be extrapolated to research on online communities of practice as they continue to be the focus of much attention.

1. The Earth Forum community is just one of four Education and Public Outreach communities functioning within the online workspace. The others are Astrophysics, Heliophysics, and Planetary Science. Each forum is managed and facilitated by a different organization and they have community specific areas of their own within the workspace. Differences exist in the management and facilitation of each of the forums and these differences are likely to translate into difference in community member utilization of the workspace. Expanding this research project to include all four forums would offer possible insight into what effects the different management and facilitation efforts have on community member participation and further offer better focused and collaborative efforts between and among the forums.
2. The online workspace is a fairly new addition to the Earth Science Education and Public Outreach Forum. This research represents

participation during the first year of the workspace's existence. While the results here are valuable, they would hold additional value if placed in the context of multiple year study. Information about participation and promotion of community member engagement continues to be collected and should be utilized.

3. This research has illustrated the possible change in mindset held by participating community members when it comes to the nature of co-location. This would be of particular importance to future of online participation and merits further exploration into the nature and extend of the changes in member feelings about participation, the meaning of membership, the sense of belonging, and the feelings of connectedness with other community members as a result of participating online.
4. Who are the community members that become the most highly active users? One possibility is that the leaders of the community prior to the introduction of the online workspace component continued to be the leaders of the community utilizing the new medium of interaction. In this sense, they online workspace has been used to amplify their historically vocal position. Another is that different members of the community feel more comfortable "leading" or are empowered by the new medium of the online workspace component and so have emerged as highly active users because of their comfort in the forms of interaction.

While some findings from this study were expected, others came as a surprise. It was expected that the more frequently community members engaged in the online

workspace the easier navigation would be for them, the greater input they would have in developing knowledge, and that they would emerge as leaders of the community if they were not already. What was not expected was the changes in perception of those highly active participants that has emerged from the data. As participation comes ubiquitous, there seems to be less a feeling or participating in an online workspace and more a feeling of participating as part of or with the community. The medium facilitating participation has moved to the background and collaboration has moved to the foreground. Highly active members have changed what it means to interact. No longer does meeting someone to work on something necessitate a face-to-face physical gathering. Making the replacement easier seems to be the ease of interaction, sharing of information and documents, exchange of ideas, and collaborative nature of the online workspace.

What this might mean for communities of practice is that as members become more familiar with working and sharing in the new medium of online communities we may begin to see changes in output. Perhaps this new medium will become the normal means of collaboration for many and allow for interaction in ways not previously possible. Removing the constraints of time and place may promote new forms of collaboration, may change the meaning of co-location, may transform how companies view and care for knowledge. We are at a time of transition as communities of practice move from traditionally co-located settings to online sites facilitated and allowing for all of the normal activities that occur when meeting face-to-face. This is likely to have a great impact on how communities of practice are

viewed by all sectors and what importance they have to “doing business as usual” in the twenty first century.

REFERENCES

Abbott, J. (1996). 7 Principles of learning: challenging fundamental assumptions. Retrieved from http://www.newhorizons.org/trans/abbott.htm

Abma, T. (2007). Situated learning in communities of practice: Evaluation of coercion in psychiatry as a case. *Evaluation*, *13*(1), 32-47.

Allen, B., Kligyte, G., Boble, M., & Pursey, R. (2008). *Communities of practice: a community dimension for the UNSW Learning & Teaching Exchange*. Paper presented at the 25th annual ASCILITE conference, Melbourne, AU.

Ardichivili, A., Maurer, M., Li, W., Wentling, T., and Stuedemann, R. (2006). Cultural influences of knowledge sharing through online communities of practice. *Journal of Knowledge Management, 10*(1), 94-107.

Ardichvilli, A., Page, V., & Wentling, T. (2003). "Motivation and barriers to participation in virtual knowledge sharing in communities of practice". *Journal of knowledge management 7*(1): 64–77.

Baek, E., & Barab, S. (2005). A study of dynamic design dualities in a web-supported community of practice for teachers. *Educational Technology and Society*, *8*(4), 161-177.

Bandura, A. (1977). *Social Learning Theory*. New York, NY: General Learning Press.

Becker, G. (1993). Human capitol. Retrieved from https://webspace.utexas.edu/hcleaver/www/330T/350kPEEBeckerHumanKtable.pdf

Bereiter, C. (2002). *Education and mind in the knowledge age*. Mahwah, NJ: Lawrence Erlbaum.

Bhagat, R., Kedia, B., Harveston, P., & Triandis, H. (2002). Cultural variations in the cross-boarder transfer of organizational knowledge: an integrative framework. *The Academy of Management Review*, *27*(2), 204-221.

Bielaczyc, K., & Collins, A. (1999). Learning communities in classrooms: a reconceptualization of educational practice. In: C. Reigeluth (Ed.), *Instructional-design theories and models. A new paradigm of instructional theory*, (vol. 2, pp. 269-292). Mahwah, NJ: Lawrence Erlbaum Associates.

Boetcher, S., Duggan, H., & White, N. (2002). *What is a virtual community and why would you ever need one?* Retrieved from http://www.fullcirc.com/community/communitywhatwhy.htm

Borthick, F., & Jones, R. (2000). The motivation for collaborative discovery learning online and its application in an information systems assurance course. *Issues in Accounting Education 15*(2): 181-210.

Bostrom, R., Anson, R., and Clawson, V. (1993). Group facilitation and group support systems. In *Group support systems: New Perspectives*. Ed. L. Jessup and J. Valacich. New York, NY: Macmillan Publishing.

Brannigan, N. (2009). The virtual community of practice as an appropriate model for learning in collectivist cultures. *GESCI,* retrieved from http://www.gesci.org/integration-of-icts-into-teaching-and-learning.html

Brett, J. (2002). *The psychology of work: Theoretically based empirical research*. New York, NY: Psychology Press.

Brown, J., & Adler, R. (2008). Minds on fire: open education, the long trail, and learning 2.0. *Educause Review*, *43*(1), 16-32.

Brown, J., Collins, A. & Duguid, S. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18*(1), 32-42.

Brown, J., & Duguid, P. (2000). *The social life of information*. Cambridge, MA: Harvard Business School.

Brown, J., & Duguid, P. (2001). Organizational learning and communities of practice: Toward a unified view of working, learning, and innovation. *Organizational Science*, *2*(1), 40-57.

Contu, A., & Willmott, H. (2000). Comment on Wenger and Yanow, Knowing in practice: a 'delicate flower' in the organizational learning field. *Organization, 7*(2), 269–76.

Cooperrider, D., & Srivastava, S. (1987). Appreciative inquiry in organizational life. *Research in Organizational Change and Development*, *1*, 129-169.

Coppola, N. (1999). Setting the discourse community: tasks and assignments for the new technical communities service course. *Technical Communication Quarterly*, *8*(3), 249-267.

Cordray, D. S., & Fischer, R. L. (1994). Synthesizing Evaluation Findings. In J. Wholey, H. Hatry, & K. Newcomer (Eds.), *Handbook of Practical Program Evaluation (pp. 198-232)*. San Francisco, CA: Jossey-Bass.

Cox, A. (2005). What are communities of practice? A comparative review of four seminal works. *Journal of Information Science*, *31*(6), 527-540.

Creswell, J. (2008). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. New York, NY: SAGE Publications.

Cristianini, N., & Shawe-Taylor, J. (2004). *Kernel Methods for Pattern Analysis*. Boston, MA. Cambridge University Press.

Davenport, E., & Hall, H. (2002). Organizational knowledge and communities of practice. *Annual Review of Information Science and Technology, 36*, 171–227.

Deutscher, G. (2005). *The unfolding of language: An evolutionary tour of mankind's greatest invention*. New York, NY: Holt and Company.

Dowman, M., Kirby, S., & Griffiths, T. L. (2006). Innateness and culture in the evolution of language. In A. Cangelosi, A. Smith, & K. Smith (Eds), *The Evaluation of Language: Proceedings of the 6th International Conference on the Evolution of Language*. Rome, Italy: World Scientific.

Dube, L., Bourhis, A., & Jacob, R. (2006). Towards a typology of virtual communities of practice. *Interdisciplinary Journal of Information, Knowledge, and Management*, *1*, 69-93.

Fischer, G., & Scharff, E. (2002). Learning technologies in support of self-directed learning. *Journal of Interactive Media in Education*. Obtained from http://jime.open.ac.uk/jime/article/viewArticle/1998-4/26

Gannon-Leary, P., & Fontainha, E. (2007). Communities of practice and virtual learning communities: benefits, barriers, and success factors. *eLearning Papers*, 5.

Gherardi, S., & Nicolini, D. (2000). The organizational learning of safety in communities of practice. *Journal of Management Inquiry*, *9*(1), 7-18.

Gilley, A. & Kerno, S. (2010). Groups, teams, and communities of practice: a comparison. *Advances in Developing Human*, *12*(1), 46-60.

Glassop, L. I. (2002). The organizational benefit of teams. *Human relations, 55*, 225-249.

Gongla. P., & Rizzuto C. R. (2001). Evolving communities of practice: IBM global services experience. *IBM Systems Journal,* 40(4), 842-862.

Hara, N. & Hew, K. (2007). Knowledge sharing in an online community of health care professionals, a comparative analysis. *The Information Society*, *15*, 241-148.

Haythornthwaite, C., Kazmer, M., & Robins, J., Shoemaker, S. (2000). Community development among distance learners: Temporal and technological dimensions. Journal of Computer-Mediated Communication. Retrieved from http://jcmc.indiana.edu/vol6/issue1/haythornthwaite.html.

Hildreth, P., & Kimble, C. (2002). The duality of knowledge. *Information Research*, *8*(1), 142.

Hildreth, P., & Kimble, C. (2004). *Knowledge Networks: Innovation Through Communities of Practice*. Hershey, PA: Idea Group Publishing.

Hildreth, P., Kimble, C., and Wright, P. (1998). Computer mediated communications and communities of practice. *Proceedings of Ethicomp'98*. Erasmus University, The Netherlands, 275-286.

Hoadley, C., & Kilner, P. (2003). Using technology to transform communities of practice into knowledge-building communities. *SIGGROUP Bulletin*, *25*(1), 31-40.

Huffman, J., & C. Hipp. 2003. *Re-culturing schools as professional learning communities.* Lanhan, MD: Scarecrow Education.

Hung, D., & Chen, D. (2001). Situated cognition: Vygotskian thought and learning from the communities of practice perspective: Implications for the design of web-based e-learning. *Education Media International*, *38*(1), 3-12.

Hutchins, E. (1995). *Cognition in the Wild*. Cambridge, MA: MIT Press.

Johnson, C. (2001). A survey of current research on online communities of practice. *Internet and Higher Education*, *4*, 45-60.

Johnson, E., & Khalidi, R. (2005). Communities of practice for development in the Middle East and North Africa. *KM4D Journal*, *1*(1), 69-110.

Johnson, H. (2007). Communities of practice and international development. *Progress in Developmental Studies*, *7*(4), 277-290.

Katz, P. (1994). The new urbanism: toward an architecture of community. New York, NY. McGraw-Hill Professional.

Katzenbac, P., & Smith, D. (1994). *The Wisdom of Teams: Creating the High-Performance Organizations*. New York, NY: Reed Business Information.

Kerno, S. (2008). Limitations of communities of practice: a consideration of unresolved issues and difficulties in the approach. *Journal of Leadership and Organizational Studies*, *15*(1), 69-78.

Kerno, S., & Mace, S. (2010). Communities of practice: Beyond teams. *Advances in Developing Human Resources*, *12*(1), 78-92.

Kibble, C., Li, F., & Blanchflower, A. (2000). Overcoming the barriers to virtual team working through communities of practice. Retrieved from http://www.chris-kimble.com/Courses/hi-2/Virtual_Teams.pdf

Kimble, C., & Hildreth, P. (2004). Communities of practice: going one step too far? Retrieved form http://ssrn.com/abstract=634642.

Kimble, C., Hildreth, P., & Wright, P. (2001). Communities of practice: Going virtual, Chapter 13 in Y. Malhotra (Ed.) *Knowledge Management and Business Model Innovation*. Hershey, PA: Idea Group.

Kirkwood, K. (2006). If they build it, they will come: Creating opportunities for e-learning communities of practice. *Universitas 21 Conference on E-Learning and Pedagogy*. Guadalajara, Mexico.

Knowles, M., Holton, E., & Swanson, R. (1998). *The adult learner: the definitive classic in adult education and human resource development* (5th Ed.). Houston, TX: Gulf.

Kondratova, I., & Goldfarb, I. (2004). Virtual communities of practice: designing for collaboration and knowledge creation. Proceedings of the European Conference of Products and Process Modeling. Retrieved from http://nparc.cisti-icist.nrc-cnrc.gc.ca/npsi/ctrl?action=rtdoc&an=5763198&article=0

Krackhardt, D. (1990). Assessing the political landscape: Structure, cognition, and power in organizations. *Administrative Science Quarterly*, *35*, 342-369.

Krumsvik, R. (2005). ICT and community of practice. *Scandinavian Journal of Educational Research*, *49*(1), 27-50.

Lave, J. (1988). *Cognition in practice: Mind, mathematics, and culture in everyday life*. Cambridge, UK: Cambridge University Press.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.

Lesser, E., & Storck, J. (2001). Communities of practice and organizational performance. *IBM Systems Journal*, *40*(4), 831-841.

Li, L., Grimshaw, J., Nielsen, C., Judd, M., Coyte, P., & Graham, I. (2009). Evolution of Wenger's concept of community of practice. *Implementation Science*, *4*(11), 1-8.

Liedka, J. (1999). Linking competitive advantage with communities of practice. *Journal of Management Inquiry*, *8*(1), 5-16.

Lima, J., Carvalho, C., & Ambrosio, A. (2007). Knowledge management in virtual communities of practice. In P. Virtanen and N. Helander (Eds.) *Knowledge Management*. InTech Publishing. Retrieved from http://www.intechopen.com/articles/show/title/knowledge-management-in-virtual-communities-of-practice.

Lueg, C. (2000). Where is the action in virtual communities of practice? Proceeding of the Workshop Communication and Cooperation in Knowledge Communities at the D-CSCW. Retrieved from http://www.realworldmatters.net/cpl/papers/commdcscw00.pdf

McClure, M., & Faraj, S. (2000). It is what one does: Why people participate and help others in electronic communities of practice. *Journal of Strategic Information Systems*, 9, 155-173.

McDermot, R. (2000). Building a support structure for your communities. *Knowledge Management Review*, *3*(3), 5.

Mieszkowski, K. (2000). Community standards. *Fast Company*, *38*, 369. Retrieved from http://www.fastcompany.com/online/38/ideazone.html

Moreno, A. (2001). Enhancing knowledge exchange through communities of practice at the Inter-American Development Bank. *Aslib Proceedings*, 53(8), 296-308.

Murillo, E. (2008). Searching Usenet for virtual communities of practice: using mixed methods to identify the constructs of Wenger's theory. *Information Research*, *13*(4), 1-23.

Nachmias, R., Mioduser, D., Oren, A., & Ram, J. (2000). Web-supported emergent-collaboration in higher education courses. Educational Technology and Society. Retrieved from http://www.ascusc.org/jcmc/vo16/issue1/haythornthwaite.html.

Neus, A. (2001). Managing information quality in virtual communities of practice. Retrieved from http:www.opensource.MIT.edu/papers/Neus.pdf

Nichani, M. (2000). Learning through social interactions (online communities). *Elearningpost.com*. Retrieved from http://www.elearningpost.com/elthemes/comm.pdf

Nickols, F. (2003). Communities of practice: an overview. Retrieved from http://waterwiki.net/images/8/82/CoPOverview.pdf

Oliver, R., & Herrington, J. (2000). Using situated learning as a design strategy for Web-based learning. In: B. Abbey (Ed), *Instructional and cognitive impacts of Web-based education* (178-191). Hershey, PA: Idea Publishing Group.

Orr, J. (1996), *Talking about machines: An ethnography of a modern job*. New York, NY: Cornell University Press

Overholt, S. (2004). Wireless in San Diego. *Fast Company,* Retrieved from http://www.fastcompany.com/magazine/78/wireless.html

Palloff, R., & Pratt, K. (1999). Building learning communities in cyberspace: Effective strategies for the online classroom. San Francisco, CA: Jossey-Bass.

Palloff, R., & Pratt, K. (2001). *Lessons from the cyberspace classroom: the realities of online teaching*. San Francisco, CA: Jossey-Bass.

Parker, M., Patton, K., Madden, M., & Sinclair, C. (2010). From committee to community: The development and maintenance of a community of practice. *Journal of Teaching in Physical Education*, *29*, 337-357.

Pemberton, J., Mavin, S., & Stalker, B. (2007). Scratching beneath the surface of communities of (mal)practice. *The Learning Organization*, *14*, 62-73.

Perkins, D. (2003). *King Arthur's round table: how collaborative conversations create smart organizations*. Hoboken, NJ: Wiley.

Persichitte, K. (2000). A case study of lessons learned from the Web-based educator. In B. Abbey (Ed.), *Instructional and cognitive impacts of Web-based instruction* (192-199). Hershey, PA: Idea Publishing Group.

Polin, L. (2008). Graduate professional education from a community of practice perspective. In C. Kimble, P. Hildreth, and I. Bourdon (Eds.) *Communities of Practice: Creating Learning Environments for Educators* (vol. 2). Charlotte, NC. Information Age.

Powers, S., & Guan, S. (2000). Examining the range of students needs in the design and development of a web-based course. In B. Abbey (Ed.) *Instructional and Cognitive Impacts of Web-Based Education*. New York, NY: Idea Group.

Prensky, M. (2001). Digital natives, digital immigrants (part 1). *On The Horizon*, *9*(5), 1-6.

Putnam, R. (1996). Robert Putnam responds. *The American Prospective*, 25. Retrieved from www.prospect.org/archives/25/25-cnt4.html.

Ramaswamy, R., Storer, G., & Van Zeyl, R. (2005). Designing sustainable communities of practice at CARE. *KM4D Journal*, *1*(1), 79-93.

Ramondt, L. (2008). Online CoPs: towards the next generation in C. Kimble, P. Hildreth, and I. Bourdon (Eds.) *Communities of Practice: Creating Learning Environments for Educators* (vol. 2) (pp. 231-234). Charlotte, NC: Information Age.

Riel, M., & Polin, L. (2004). Online learning communities: common ground and critical differences in designing technical environments. In Designing for Virtual Communities in S. Barab, R. Kling, and J. Gray (Eds.) *Designing for Virtual Communities in the Service of Learning.* Cambridge, MA: Cambridge University.

Rheingold, H. (1993). *The virtual community: Homesteading on the electric frontier.* Reading, MA: Addison-Wesley.

Roberts, J. (2006). Limits to communities of practice. *Journal of Management Studies*, *43*, 623-639.

Robey, D, Khoo, H., & Powers, C. (2000). Situated learning in cross-functional virtual teams. *Technical Communications*, *47*(1), 51-66.

Rogers, J. (2000). Communities of practice: A framework for fostering coherence in virtual learning communities. *Educational Technology and Society*, *3*(3), 384-392.

Rogers, Y., Sharp, H., & Preece, J. (2008). *Interaction Design: Beyond Human – Computer Interaction.* New York, NY: Wiley.

Saint-Onge, H. (2011). *Leveraging Communities of Practice for Strategic Advantage*. New York, NY: Routledge.

Schlager, M. S., Fusco, J., & Schank, P. (1998, December). Cornerstones for an online community of education professionals. *IEEE Technology and Society Magazine*, Special Issue: Wired Classrooms: The Internet in K-12.

Schlager, M. S., Fusco, J., & Schank, P. (2002). Evolution of an on-line education community of practice. In K. A. Renninger and W. Shumar, 129-158, (Eds.), *Building virtual communities: Learning and change in cyberspace.* NY: Cambridge University Press.

Schlager, M. & Fusco, J. (2004). Teacher professional development, technology, and communities of practice: Are we putting the cart before the horse? In S. Barab, R. Kling, and J. Gray (Eds.) *Designing for Virtual Communities in the*

Service of Learning. (pp. 84-117) Cambridge, MA: Cambridge University Press.

Scott, W. R. (2003). *Organizations: Rational, natural, and open systems.* Upper Saddle River, NJ: Prentice Hall.

Seely Brown, J. & Duguid, P. (1991). Organizational learning and communities of practice. *Organizational Science*, *2*(1), 40-57.

Serrat, O. (2008). Building communities of practice. Knowledge Solutions. Retrieved from http://www.adb.org/Documents/Information/Knowledge-Solutions/Building-Communities-Practice.pdf.

Seufert, S. (2002). Design and management of online learning communities. EURAM. Retrieved from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CDsQFjAB&url=http%3A%2F%2Fwww.researchgate.net%2Fpublication%2F36386875_Design_and_Management_of_Online_Learning_Communities%2Ffile%2F32bfe51151beebb5c3.pdf&ei=0yvSUd24JbDE4APFkoDYDg&usg=AFQjCNHyH4x09wLb_wSNibcHPc1TxIR4eQ&sig2=eXqV3OHVHUc5beZi-rCguw&bvm=bv.48572450,d.dmg

Shaffer, C., & Anundsen, K. (1993). *Creating community anywhere: Finding support and connection in a fragmented world.* New York, NY: Tarcher/Pedigree Books.

Shaffer, D., Squire, K., Halverson, R., & Gee, J. (2004). Video games and the future of learning. *Phi Delta Kappa*, *87*(2), 104-111.

Smith, M. (2007). 'Robert Putman,' the encyclopedia of informal education. Retrieved from www.infed.org/thinkers/putnam.htm.

Squire, K., & Johnson, C. (2000). Supporting distributed communities of practice with interactive television. *Educational Technology Research and Development*, *48*(1), 23-43.

Stemke, J., & Wilson, L. (2009). Expert knowledge transfer: Solving strategic challenges, setting the stage for next-generation management systems. APQC's 14th Knowledge Management Conference. Retrieved from http://www.knowledgeharvesting.com/documents/Knowledge%20Harvesting%20@%20Chevron%20-%20APQC%202009%20Presentation.pdf

Stuckey, B. & Smith, J. (2004). Building sustainable communities of practice. In P. Hildreth and C. Kimble (Eds.) *Knowledge Networks: Innovation Through Communities of Practice*. (pp. 18-67). Hershey, PA: Idea Publishing.

Tapscott, D. (1997). *Growing up digital: The rise of the net generation*. New York, NY: McGraw-Hill.

Teigland, R., & Wasko, M. (2007) Extending richness with reach: Participation and knowledge exchange in electronic networks of practice. In P. Hildreth and C. Kimble (Eds.) *Knowledge Networks: Innovation Through Communities of Practice*. (pp. 18-67). Hershey, PA: Idea Publishing.

Terkel, S. (1975). *Working*. New York, NY: Avon.

Thomas, A. (2005a). Children online: Learning in a virtual community of practice. *E-Learning*, *2*(1).

Thomas, A. (2005b). *Critical teaching and everyday life*. Chicago, IL: University of Chicago Press.

Trayner, B. (2010). The art of convening complex learning encounters. In Learning in *Landscapes of Practices*. (Eds), (pp.23-31). UK: Open University Press.

Vann, K., & Bowker, G. (2001). Instrumentalizing the truth of practice. *Epistemology, 15*(3), 247–62.

Vygotsky, L. (1978). *Mind in Society*. Cambridge, MA: Harvard University Press.

Wasko, M., & Faraj, S. (2000). It is what one does: Why people participate and help others in electronic communities of practice. *Journal of Strategic Information Systems*, *9*(2-3), 155-173.

Wenger, E. (1998a). *Communities of practice: learning, meaning, and identity*. New York, NY: Cambridge University.

Wenger, E. (1998b). Communities of practice: Learning as a social system. Systems Thinker. Retrieved from http://www.co-i-l.com/coil/knowledge-garden/cop/lss.shtml.

Wenger, E. (2000). Communities of practice and social learning systems. *Organization*, *7*(2), 225-246.

Wenger, E. (2001). Supporting communities of practice: A survey of community-oriented technologies. Retrieved from http://www.ewenger.com/tech.

Wenger, E. (2002). *Cultivating communities of practice: A guide to managing knowledge*. Boston, MA: Harvard Business School Press.

Wenger, E. (2004). Communities of practice: A capability-development approach to strategy. Retrieved from http://www.ewenger.com/services/servworkshops.htm.

Wenger, E. (2006). Communities of practice: A brief introduction. Retrieved from http://www.ewenger.com/theory/index.htm.

Wenger, E., McDermott, R., & Snyder, W. (2002). *Cultivating communities of practice: a guide to managing knowledge.* Boston, MA: Harvard Business School Press.

Wenger, E., & Snyder, W. (2000). Communities of practice: The organizational frontier. *Harvard Business Review*, *78*, 139-145.

Wenger, E., Trayner, B., & DeLaat, M. (2011). *Promoting and assessing value creation in communities and networks: A conceptual framework*. Report 18. Heerlen: Open University, Ruud de Moor Centrum.

Wenger, E., White, N., & Smith, J. (2009). *Digital habitats: Stewarding technology for communities*. Portland; OR: CPsquare

Wenger, E., White, N., Smith, J., & Rowe, K. (2005). Technology for communities. In L. Langelier (ed.), *Working, Learning and Collaborating in a Network: Guide to the implementation and leadership of intentional communities of practice*, (p. 71-94). Quebec City, Quebec: CEFIRO.

Wenjing, X. (2005). Virtual space, real identity: exploring cultural identity of Chinese diaspora in virtual community. *Telematics and Informatics*, *22*(4), 395-404.

White, I., & Pagano, R. (2007). Making it stick: The use of online discussion forum to support continuing professional development in higher education communities of practice. *Proceeding of the 2nd International Conference on E-learning*, New York, 28-29 June.

Wick, C. (2000). Knowledge management and leadership opportunities for technical communicators. *Technical Communication*, *47*(4), 515-529.

Wiessner, C., Hatcher, T., Chapman, D., & Storberg-Walker, J. (2008). Creating new learning at professional conferences: An innovative approach to conference learning, knowledge construction and programme evaluation. *Human Resources Development International*, *11*, 367-383.

Williams, L. A., L. Atkinson, J. Cate,, & M. J. O'Hair (2008). Mutually supportive relationships between learning community development and technology integration impact school practice and student achievement. *Theory Into Practice Journal 47*(4), 294–302.

Winsor, D. (2001). Learning to do knowledge work in systems of distributed cognition. *Journal of Business and Technological Communication*, *15*(1), 5-28.

Wisner, P. S., & Feist, H. A. (2001). Does teaming pay off? *Strategic Finance, 82*(8), 58-64.

APPENDIX A

Permission to Use 5D Image

Dear Brad,

I give you permission to use the 5D image in your dissertation. I would be interested in reading your dissertation when it is done.

Regards

Rohit

Rohit Ramaswamy, PhD, MPH, Grad. Dipl. (Bios)

Director, Center for Global Learning

Clinical Associate Professor

Public Health Leadership Program

Gillings School of Global Public Health

4107 McGavran-Greenberg Hall, CB #7469

135 Dauer Drive, Chapel Hill, NC 27599, USA

Phone: +1 515 988 5124

APPENDIX B

Informed Consent

Earth Science Education and Public Outreach Community Member,

My name is Bradford Davey. I am a doctoral candidate in Learning Technologies at Pepperdine University, Graduate School of Education and Psychology under the supervision of Dr. Margaret Riel. I am interested in learning more about your experiences with the online workspace and how it may have affected your work.

I would like to ask for your participation in a survey that will help me identify the impact participating has had on you. Completing the survey is completely voluntary. Should you choose not to complete the survey, this will in no way affect your standing in the Earth Forum Community in any way.

The survey should take about 10 or 15 minutes to complete. The survey asked questions about your usage of the online workspace, your level of interest, the value of the workspace, and what changes, if any, you would like to see made. I will also be asking for your email address so that I may contact members chosen at random to be interviewed further about their experience. You have the right to refuse to answer any questions you choose not to answer.

The only foreseeable risk associated with participation in this study are the amount of time involved. Although you may not directly benefit, a potential benefit of participating is providing information that can help NASA make improvements to the online workspace and help NASA determine the future utilization of such environments.

When the results of the survey are shared with NASA and research community, the information you provided will describe the group as a whole and not individual community members. To further protect your privacy, I am not asking you to provide any personally identifying information other than your email address which will not be connected to your responses when reporting. Your responses will be kept anonymous as part of this research study and stored on my personal computer where they will be password protected in a partitioned area of the hard drive. Please do not write your name and any other contact information on any portion of the survey.

I am required to keep the information collected for this study in a secure manner for at least three years. After the survey information is no longer required for research purposes, the information will be destroyed.

A summary of the findings may be obtained in approximately 6 months at the annual retreat. The summary will also be made available through the online workspace for you to review at your convenience. You may review the findings whether you elect to participate in the survey or not.

Feel free to contact me with any questions or comments regarding this study at brad@techforlearning.org or (401) 465-9323. If you have further questions about the

study, you may contact my dissertation chairperson, Dr. Margaret Riel, Pepperdine University, Graduate School of Education and Psychology, 6100 Center Drive, Los Angeles, CA 90045. If you have any questions about your rights as a study participant, you may contact Stephanie Woo, Ph.D., Chairperson of the Graduate and Professional Schools Institutional Review Board, Pepperdine University, Graduate School of Education and Psychology, 6100 Center Drive, Los Angeles, CA 90045. Please follow the link provided to start the survey. I do hope you will choose to participate in this study. Thank you in advance for your time.

Sincerely,

Bradford Davey
Pepperdine University
Graduate School of Education and Psychology
6100 Center Drive
Los Angeles, CA 90045

Follow-Up Email

Recently, you received a survey request from Brad Davey, doctoral student and our program evaluator, to complete a survey on your participation in the online workspace. This email is a follow-up, reminding you, if you have not yet done so, to complete the survey as soon as possible. Brad's research is of critical importance to our continued efforts to provide you with the very best possible means to facilitate the work that you do. If you have already completed the survey, thanks!

Sincerely,
Theresa Schwerin

APPENDIX C

Community Member Survey

The following survey has been designed to gather information from those participating in the SMD E/PO Earth Forum Online Community workspace.

Please rate your level of interest in the online workspace at the different indicated times on a scale from 1-5 where 5 is the highest.

When first opened – August 2010
Half way through – March 2011
Now – January 2012

What was the greatest limiting factor to your participation in the online workspace?

Time
Interest
Technology
Navigation
Not enough useful information
No unique information
No live chat function
Can't search people by expertise
Other _____

Please rate your willingness to continue to participate in the online workspace and indicate why you chose the level you did. (1=not willing to participate -5=very willing)
1 – 5
Please explain your response.

What do you feel should be the purpose of the online workspace (Please check all that apply) or what do you think it is for?

Promote knowledge building
Share individual information
Increase sociability among forum members
Provide a space to interact with other E/POs
Share documents
Cooperate with other forum members on projects
Build teams
Provide archive of forum information and activities
Provide current news, events, data calls from headquarters
Other _____

Please share your experience and perceptions about the workspace by rating the following on a scale from 1 to 5 with 1=strongly disagree and 5=strongly agree.

The workspace has the information I expected
It is east to navigate to the resources I am search for

The workspace is useful
The workspace is attractive
The workspace layout is intuitive
Please share any additional perceptions

How well are you able to navigate the online workspace now compared with when you first began to use it? Please use the scale from 1-5 with 1= not able to navigate at all and 5=very easy to navigate.

When you first began
Now

Please rate the short term and long term value of the online community workspace on a scale from 1-5 with 1 being no value and 5 being a very high value to each of the following.

__ Your own work as an E/PO professional
__ Your knowledge of Earth Science issues and ideas
__ Your knowledge of Earth Science community events and news
__ Your knowledge of Forum events and news
__ The Earth Science community's work as a whole
__ Collaboration efforts between E/PO professionals in the forum
__ Getting the word out about my E/PO project
__ Communicate with other members

How often have you done any of the following in the workspace?
Daily, 2-3 times/week, Weekly, 2 times/month, Monthly, Only once or twice

	Daily	2-3/wk	1/wk	2/mo	1/mo	1-2 times
Accessed individual profiles						
Offered knowledge or experiences						
Gained any skills						
Shared upcoming events						
Shared resources						
Collaborate with colleagues						

Has participating in the online workspace made you feel more like you belong to this community of educators?

Yes
No
Please explain

Do you feel that the Earth Forum has encouraged your participation in the online workspace?

Yes
No
Please explain

Do you feel that participation in the online workspace helped to further develop your knowledge or expertise?

Yes
No
Please explain

Was there an instance where you were able to solve a problem working with a colleague through engagement in the online workspace?

Yes
No
Please explain

What changes would you like to see made to the online workspace?

Please provide any experience you have had in which the online community provided value to you personally.

APPENDIX D

Community Member Interview Items and Protocol

You have been asked to participate in this interview because you have been a participant in the Earth Forum's online workspace. Your participation is voluntary and you can opt out at any time. The researcher will be using the data collected here to develop a further understanding of the value the online workspace has for the Earth Forum community members such as yourself. Your responses to the following questions will be kept anonymous and only the researcher will have any information about who gave them.

Value-Creation Story Interview

1. Describe a meaningful activity you participated in and your experience of it (eg., a conversation, a working session, a project, etc.).
2. Describe a specific resource this activity produced for you (eg., an idea or a document) and why you thought it might be useful.
3. Tell how you used this resource in your practice and what it enabled that would not have happened otherwise.
4. Outcome
    a. Explain how it affected your success
    b. Has your participation contributed to the success of your organization – how?
5. Sometimes, such a story changes your understanding of what success is. If this happened this time, please describe.

APPENDIX E

Organizational Member Survey

The following survey has been designed to gather information from those responsible for developing and administrating the SMD E/PO Earth Forum Online Community workspace. Please complete all the items as completely as possible and provide examples or explanations were you can.

What role do you play with regard to the online workspace?

How instrumental were you in helping to design the online workspace? Please explain.

- Very instrumental
- Somewhat instrumental
- Not very instrumental
- Not involved in the design at all

What components of the online workspace do you feel are intended to contribute to knowledge building in the community?

What efforts were taken to help members develop knowledge and expertise?

How has the online workspace helped to support the work of the Earth Science community?

How would you describe the level of facilitation necessary to help maintain the online community? Please describe.

- High – daily
- Moderate – weekly
- Low – monthly

What different actions did you or the management team take to help facilitate and promote participation in the online workspace?

What value has the online workspace added to the Earth Science community and E/PO efforts?

APPENDIX F

Interview Responses

How Often Interviewed Community Members Utilize the Online Workspace

Level	Description of usages
High "H"	Go in when I get an email about something new – three or four times a week On the workspace several times a day - I choose to use it as my home page - I can always see any announcements and respond to them everyday Log-in daily to review new news and events I was part of the planning committee and go to the workspace almost every day Once or twice a day
Medium "M"	Depends on what I am working on. Mostly every other day or at least once a week. I did not go in much but am beginning to go to the workspace more and more. Often/once a week L - Very little use - read emails Use it somewhat - once a week sometimes and then once a month other times I use it several times each week - two to three
Low "L"	Perhaps once a month more or less. Only once in a while. I receive emails that direct me to the workspace Very little - logged in a few times following email links Once a month or every couple of months Seldom to never. Once a month or so at best.

Describe a meaningful activity you participated in and your experience of it (eg. a conversation, a working session, a project, etc.).

H	Followed a link once and commented on something that someone was talking about in a discussion board. Someone was looking for information and I was able to give an example
H	Only one real place that I work in the workspace regularly, the alignment activity workgroup. We upload our work every Friday for everyone to see. I never remember how to get to the place I need to be. Not at all clear to me. So, I have a word doc that I created to help me navigate to where I need to go. Finding things is also very difficult.
H	I have been able to connect to a different community of educators and continue to work with others in new ways
H	Most of the activities I participate in the workspace are meaningful. One instance, my working group worked on a document to be shared with the larger community on utilizing available resources from within NASA including scientists and engineers for talks/webcasts, etc.
H	I work with a few different groups so am in the workspace often. I recently worked with a planning group for the annual retreat. We worked together,

	shared docs, posted discussions, etc.
M	Couple of things come to mind. 1) I am on a task force and we have set up our own space to work on. I jumped into that right away and that has been really good. It is a great place for small groups to work. However, it was difficult to get some of the others to see the added materials. Need training as a community to use the community effectively. 2) Was able to set up a group of my own design that is being used for our own work
M	I posted to a discussion board and received a few responses that have turned into collaborations
M	I've participated in several meaningful activities. One very small example - that is most current - was providing feedback to the Informal Education Working Group (IEWG) on the NASA SMD online catalogue metadata from an informal perspective. Our group leaders posted an announcement of an assignment and the materials needed for the assignment on the workspace, and we were able to provide our feedback there - without the need for an additional telecon, and such that we could complete the assignment on our own time by a specified deadline.
M	Most important to me has been having all of the documents for the forum in once place. Use to be lots of emails flying around that had things. Now, even if I don't have it on my personal computer, I know where it is and how to get it.
M	I use it for two primary things. One - we get email summaries and that prompts me to visit the website if it s teaser to me that links me directly to the story or news. Two - when we were working on our product analysis. It is a good place to park your work and find resources that made our efforts easier. For example, when we were trying to decide what type of tool we were using, it was very helpful to go into the workspace and look at the assessment tools there and get clarity on using them and what teaching methods were being used. Great knowledge there.
L	Yes - when I first was beginning I found a doc about the new initiatives from the working group on educations. This document was very valuable for me in developing my E/PO plan for the year. It gave me lots of focus. I am now learning about the next generation standards. I have posted a discussion topic about the next gen science standards. No responses as of yet.
L	Not using the space because not sure how to use it. Not sure without a need how to use it. If I were to partner with another community member we might use it together. Not sure what they purpose is. There are so many other tools that can be used such as file sharing, email, telecons, Google, etc.
L	I have read a few of the discussion areas. Some are interesting but others are just old and a little outdated. I do find it an easy place to get contact information for someone that I am looking for.
L	Mostly just gotten news or announcements from the workspace
L	Looked at the Nuggets and some of the HQ announcements - more NSAS HQ programmatic stuff

Describe a specific resource this activity produced for you (eg. an idea or a document) and why you thought it might be useful.

H	Nothing - don't really use it a lot
H	It says welcome and makes me feel like part of a team. The forum news is also very valuable. We share lots of documents back and forth through the workspace. The announcements are really the most meaningful to me. I get lots of useful information from them on a daily basis and it really helps me keep up with what is happening.
H	I have gotten a few new ideas about ways to present educational materials to my audiences. I have been able to use some of the new approaches and they are working very well. We have feedback from some participant that indicates this.
H	We developed an in-depth resource that has been used by many of the forum members and even those beyond the Earth forum. This process showed me that having the workspace is a valuable tool
H	This process produced the overall program outline for the annual retreat, specific supporting documents, a time line of events, fun activities, etc.
M	We have not gotten to the point where we are sharing what we have developed. We did produce a survey that went out to the forum for professional development and were able to work and share documents in the workspace to accomplish out task. The informal working group has begun a resource library in the workspace and that is going to be very useful. Will be a fantastic resource.
M	Using the discussion board, I was able to get some information from others that proved to be very helpful. They were descriptions of how to get the information from partners that I needed.
M	It's providing feedback to the IEWG leads, who can then use it to produce a document on behalf of the whole group. This is useful such that the people doing the SMD product analysis can hear from the group one time, instead of from multiple people individually.
M	Participating has not really produce anything for me but it has made me aware of what is going on around the community and I am also able to look at what some of the other forums are up to and that is helpful.
M	Used what was in the workspace to actually do my own product analysis. Working with a group, there were lots of resources there for us. Once we got over the initial hurdle of getting in there, it all went fairly easily. I wont use a tool just because it is there. I use it where there is project that I am working that will be a benefit to me to us it, I am more inclined to get involved.
L	Next gen standards doc from the E/PO community. I used this document and information to help my group start to get a lens of how to develop a continuum of different projects. Helped us also understand what our focus should be. The document looked at the new agenda and emphasis from the working team and trying to use that information to develop our own E/PO plan.
L	Entered information into the personal area Looked at a few profiles and recognized a few folks names
L	Nothing specific. Like I mentioned above, the announcements and news keep me updated
L	I have not had any resources produced by being part of the workspace
L	I used some of the slides from the AGU retreat - the presentations were given to

	my management. Reading some documents to prepare for meetings

Tell how you used this resource in your practice and what it enabled that would not have happened otherwise.

H	No - my work does not have me doing a lot of things that are being talked about in the workspace. Last year, in prep for NSTA, I was able to use the materials that Cassie posted in the workspace. The map of the booth, materials, locations, etc. It was very helpful.
H	The announcements are very helpful. We do produce a newsletter and that really does a better job of getting the information out. I prefer the newsletter format because it is easier and more clear. The workspace is really another step at times. Forum specific information is very helpful and I do not get that information from anywhere else but the workspace
H	I used the presentation ideas to reshape the way were working and it has better aligned our efforts with those of the other centers
H	Our group used it to collaboratively work together to accomplish our task and make a product that had value beyond just ourselves but for the larger community. I also find myself referring back to the document from time to time to get a name of a contact or to reach out to someone.
H	Well, I am going to be at the annual retreat so I will use it there. I think that we could have done this work without the workspace but it did make it easier and I do think that we collaborated more than we did last year without it
M	Was a combination between synchronous and asynchronous work that the workspace made possible. I don't think that this would have gone so well with just email. Using the workspace, we had a nice achieve of our work and efforts over the time. Was a nice facilitating option that we had by using the workspace. The online resource library could not have been done without the workspace.
M	I am not sure that I would have been able to come up with this on my own. That makes my experience in the workspace unique. I had tried to figure this out for about 6 months with no avail. Within a few days, I got the information I needed and was good to go.
M	I was able to provide feedback after midnight - at a time when not many other people are working. It would have difficult for me to squeeze in an extra telecon during work hours since it was assigned, but I could complete the task after hours.
M	I use the documents and postings to keep current on what is going on and what things are coming up that I need to be prepared for. There are also some docs that are like templates that help me to get the necessary things together and do my job better.
M	I was able to see what types of questions others were asking and it was very nice to see how other people interpreted some of the other teaching methodologies and we were making some very rarified decisions.
L	Gave us the idea that we needed to focus and emphasize. Middle school is now a large focus of our materials. Aligned us well with the other folks of the working group. When we presented our plan, we felt that we had given the appropriate attention to the important ideas of the community. Gave us validity.
L	Not sure how I going to make use of this tool - if it is not intuitively obvious, I do

	not want to put the time into it
L	I use the updates and news to stay current with the community. My working group is just getting started in the community and that is likely to get me in there more.
L	N/A
L	Information developed collectively as a community I used to present to my management at my center. Integrated some of that information into E/PO for Goddard

Explain how it affected your success

H	Was able to get us all on the same page and coordinate. It was nice to have this material in a network space. It is great to be able to add to the discussion.
H	Nothing that we do in the workspace could not be done outside of the workspace just as well. It is just not a good repository
H	It affects us because we are always trying to make our products and delivery better and this was a real big step in getting that to happen
H	I think that the workspace enabled us to work collaboratively. I do think that we could have done this without the workspace but being able to have a space that was 'ours' was meaningful and knowing that if I looked there, I would be able to see what everyone was working on was critical to feeling part of the process the whole way.
H	I really think that having the space to collaborate has improved our output
M	We were able to do work in a productive manner. It worked well for us to use and I think that we will use it more in the future.
M	It made things a whole lot easier. Being new, it is often difficult to figure out how to get what you need and get things done. So, having the help of some others who had gone through a similar situation was very helpful.
M	I was able to contribute!
M	One document was an outline on submitting a review. So, I used to template to set up my own and it went a lot more smoothly.
M	This could have taken much longer with lots of emails back and forth. It really focused our attention and simplified our efforts. There is an overhead of managing the information that you don't have when working in a workspace. When it is well designed space, the management of information is done by someone else.
L	Gave us validity. Help us align our efforts with the rest of the community.
L	Emails that come through help to quickly decide what to look at more. If I did not have a specific project in mind, I don not think I would use it
L	I can not say that it has made me any more successful but everything helps.
L	N/A - although having the announcements has been helpful but not really changed anything
L	It was very timely to have the information but I would say neutral as far as the information - I could have gotten it from other sources

Has your participation contributed to the success of the Earth Forum Community – how?

H	The comment I made was helpful for that person and they commented back to me to let me know. They changed some of their materials and made improvements.

	Thanked Cassie publicly for all of the work. It was nice to offer her the praise.
H	My participation in my working group is my focus and I do believe that the things that I have helped develop have contributed
H	I am not sure if our success has contributed to the community. It has made our efforts better in our community and within our programs reach.
H	I think that what we developed will have a lasting effect on the community as a whole while we recognize that not everyone needs this resource, it is still very valuable.
H	Our work is more efficient and this helps everyone
M	The majority of the work that I do for the forum is not yet in the workspace. I see it as growing it organically and this is important for the health of it over time. I have contributed to the OD group with papers and articles and data. However, most of the work that I do is not yet showing up in the workspace. I do plan to get more of the things that I produce into the workspace. It would be good to provide an archive place within the workspace to house these types of resources. Still needs to be better search able.
M	No but the help of those two others community members sure did contribute to my success.
M	I believe it will contribute to the success of the community, since our feedback will be compiled and then submitted to the cross-forum product analysis team - which will ultimately benefit all Earth Forum members who produce or utilize these types of products.
M	I am not sure I have contributed but I know that I have benefited from the contributions of others. Now, I know some feel it is redundant to have the workspace but I think that if everyone was to use it more consistently then it would make it better for everyone. How to we make this happen?
M	I have very few illusions. So, I think of it more in terms of what it has done for me. I suppose it some ways, it was easier to get comments to people who I was working with. I am not an active poster I am more of consumer than a producer.
L	Sometimes the information is so old, it is hard to tell how often it is updated. If things are over a year old, they might be moved to a different area of the forum. Discussion topics should be archived. The forum post that I started I think has lots of value for the community. It takes time to get people involved but once they are I think that many will be interested in it. I am not sure how or where to post things so that I am getting things in the right place. I do not think that people have been using the space as a collaborative space.
L	Have not asked that question but have not heard any yet. Would like to ask someone how I could make better use of the space. Most interested in the workspace as a networking tool. Gotten more out of the emails. They give me something to focus on. Not working within the space because I am not working on any of the projects.
L	I am not really participating. I am just getting news and announcements. As I mentioned, when my working group gets started in the community, I would like to think that the community will benefit from what we produce.
L	No
L	If I used it more regularly it would have more value - if it became a place that I

	needed to go to get what I needed. Documentation would be most useful to me - presentation that I could use. The other part could be some sort of interactive communications with people so it feels more of a community. Perhaps something like a Facebook or something that allows a little more back and forth. More community. Now it is mostly a repository and less of a community.

Sometimes, such a story changes your understanding of what success is. If this happened this time, please describe.

H	Having a workspace allows asynchronous collaborative work. It is more enjoyable to have synchronous work with phone and video but when those things are not possible, then having something like this is very good. This allows for participation when it works for you and when you need to. The alerts remind me that I am part of a larger group. Contributing helped make me feel part of the larger forum. I hope they are able to continue it and that it is a valuable resource. Seeing and using it was in the back of my mind when I formed another one for personal use. Many webinar participants have gone into the workspace to continue their discussions. So, I really saw that the discussions were continuing and was valuable to the people interested in the topic. Helped them work on their E/PO for social media.
H	In an ideal world, I would log into the workspace and it would be my home page. The top line of the workspace would be an updated new feed about folks from the workspace on a personal level and work level or 'check out Brad Davey's social media podcast.' Then the rest would be an easily searchable intuitive search engine. If this were to happen, it would be useful. This would really make the online workspace a very useful tool for the community. Our success could really be affected by a more useful workspace. Our tool is very static while the people are very dynamic and creative. The workspace does not reflect what the group is capable of. It limits us really. No way have I written the workspace off. I would love to see version 2 released and be what we all hoped it would be. Would really like to see it become a learning community of practice where we are updated continually.
H	Has not really changed our understanding of what success is as that is largely determined by OMB but it has made our efforts better as indicated by our group and the folks we deliver materials to
H	Did not really change my impression of what success is but I am pleased that we have a place that enables us to work together in these ways. I think that as more of the community gets into the habit of utilizing the workspace, we will see more and more stories of success like this.
H	I think about it broadly and connect ease of work and ability to communicate with people quickly, then yes, it has changed my ability to be successful. It makes things go faster. We could have had the same output without the workspace but it would have taken longer. So, yes it added to success - process success.
M	In the beginning, I was 'wow, this is great, this is great.' Now, there is just so much in there that it is becoming difficult to find things and get around in there. I do not think that we have completely assigned what success yet looks like. I am

	impressed by what some of the groups are working on and am heartened by how they are using it. This is a new way of success with success coming around our sharing of ideas in a new way. However, we have not yet built enough in the workspace that can be shared with the larger community. So success will come when it is a greater resource for the larger community. People are egger to have a single place to go with lots for them. That has lots of value for them. Success does not mean 100% participation either. We just need to get those that can find value in it to get in and start using it together.
M	I think one aspect of success is being able to work together to solve problems. The workspace seems like it is a wonderful place to see that this can happen for our community. There are lots of people out there that have good ideas and understand how things work. It is important that they be able to share their ideas and experience with the rest of the community and workspace can make that possible in a real way.
M	I don't think that happened this time... Sorry!
M	N/A
M	Not sure it has really changed what I understand to be success but we'll see…
L	Not really. Looking forward to seeing what they workspace can offer. At first, it was rather disjointed and so difficult to use. Now, especially if it keeps getting updated, I think that it will be a very valuable tool that can lead to our success. For someone new like me, it has the potential to connect me to the community.
L	Would be interested but not a practical application for it yet. I think that I fit into the group that does not have an immediate need for it so don't see how it is applicable. Don't know what is in it so don't know what to use it for.
L	Nothing like this yet but you never know.
L	N/A
L	Not really. I still see success in our audience that we are trying to reach and an online community does not really do that I think.