

ASSESSMENT LEARNING STYLE CONSIDERATIONS FOR ONLINE PROFESSIONAL SCIENCE GRADUATE PROGRAMS

Aikyna Finch¹, Darrell Norman Burrell², Vanessa Graham¹ and William Quisenberry³

¹Strayer University, USA, ²Bellevue University, USA and ³Mid-Continent University, USA

ABSTRACT

World environmental issues like the BP oil spill have increased interest on world environmental degradation and the study of Environmental Science. To meet the industry demand, more colleges and universities must develop new academic programs. The challenge is that chaos in the economy has diminished the availability of funds for new facilities and Environmental Science programs. A possible option for developing new skills and international knowledge collaboration has been the growth and emergence of on-line Professional Master of Science (PSM) Degree programs, which provide the benefit of class learning environments of students from different backgrounds, fields, industries, professions, geographical areas, and levels of experience. Before universities can actively advance into on-line learning for professional science graduate programs they must develop an understanding of learning styles in order to most effectively offer programs that provide the most effective learning communities for knowledge transfer and knowledge collaboration, which is critical for the development of effective environmental and professional applied scientists.

Keywords: *Distance Learning Science Programs, Professional Master of Science.*

INTRODUCTION

Based on shrinking financial resources and the on-going chaos in the world economy, universities are attempting to develop new programs that are responsive to sustainability, environmental protection, science innovations, and workforce development needs and the need to develop new channels for revenue. Universities are also trying to find creative ways to increase tuition revenue and grow student enrollments without increasing campus physical facilities. Several established colleges have developed on-line science related programs as a tool to develop future leaders for the industry and upgrade the knowledge base of existing professionals in the field.

The increase of environmental issues, sustainability based industries, and science based industries in areas of public health, emergency response, biotechnology, and homeland security have increased the demand for scientists and continuing education for industry professionals. Traditionally, universities met the demand through their production of Ph.D. chemists, biologists, physicists, and computer scientists, most of who worked in research and development. More recently the rise of industries based on the convergence of scientific field has increased the need for new means of developing professionals in the field. There has also been an increased need to help professionals in various industries retool their careers through the development of new academic knowledge (National Research Council, 2008).

The current university approach for producing industry scientists is that it is costly and inefficient. Graduate programs in science and mathematics are organized by discipline and focus on producing Ph.D.-level researchers. It now takes eight or nine years in addition to the bachelor's degree to earn a Ph.D. in science market (National Research Council, 2008). In the life sciences most students land their first permanent job at age 33 (National Research Council, 2008). The process of degree attainment is has several significant implications in the expensive, time spent, and lost income from not being in the workforce. These implications also discourage promising undergraduate math and science majors who cannot afford a protracted delay of their entry into the labor market (National Research Council, 2008).

The Professional Science Master's (PSM) degree represents an effective answer to both these problems. The America Competes Act has outlined these programs as a critically effective way to expand the scientific workforce through the quick and efficient production of applied scientists that many government agencies and industries need.

Many jobs in these sectors, especially those outside the lab, require more than a bachelor's degree but not a Ph.D. PSM curricula at schools across the country incorporate scientific content and business-related "plus" components. The plus components vary with the program but typically include topics such as communications, business fundamentals, project management, and intellectual property (National Research Council, 2008).

The Professional Science Master's (PSM) degree is an innovative two-year graduate degree designed to allow students to pursue advanced training and excel in science while simultaneously developing highly-valued business skills. PSM programs prepare students for science careers in business, government, or nonprofit organizations, where workforce needs are increasing (National Research Council, 2008).

Programs are developed in concert with industry and are designed to dovetail into present and future professional career opportunities. Graduates are equipped to manage the breakthroughs that are created by the research teams. They can interact between researchers and managers, especially in the marketing, finance, and legal departments (National Research Council, 2008).

The PSM degree is meant to supply intermediate-level professionals for the scientific workforce, largely in business and industry. It is a professional rather than a research degree and is intended to be equivalent to a law or business degree for young people who major in the sciences and mathematics as undergraduates. Unlike the typical science and engineering master's degree program, PSMs are not consolation prizes for those who drop out of Ph.D. programs. Instead they are terminal degrees designed in close cooperation with regional industries to prepare applied scientists and mathematicians for work in new and emerging industries (National Research Council, 2008).

PSM degree programs offer bachelor's degree holders a direct path to industry. The programs are attractive to students because they prepare them for work in a variety of cutting-edge fields and yield a highly marketable degree after just two years of postgraduate study (National Research Council, 2008).

Because of their quicker employment payoffs, PSM degree programs can encourage more college science majors to pursue postgraduate degrees. The benefits can also encourage more college students to major in science and more high school students to take science courses. Similarly, the rewards should make careers in math and science more appealing to women and minorities; indeed, 40 percent of current PSM students are women (Crawford, 2006).

According to the National Professional Master's Association (www.npsma.org) PSM programs are in fields such as:

- Biotechnology
- Forensic Science
- Environmental Public Health
- Nanoscience
- Environmental Science
- Biosecurity
- Biotechnology studies
- Sustainability
- Bioenergy
- Science Entrepreneurship

Several universities have developed innovative PSM environmental science programs. Virginia Tech University has a 16 month executive masters in Environmental Natural Resources Management and Sustainability, The University of Maryland- University College has an on-line Masters in Environmental Sciences, and Duke University has an executive Master's in Environmental Leadership

Other innovative programs focused on the innovative development of environmental scientists include, Prescott College's distance learning PhD in Sustainability and Environmental Education, A.T. University's low cost on-line

Doctor of Health Education in Environmental Health, and Marylhurst University's 18 month on-line "Green" MBA in Sustainability and Environmental Development.

Several other universities are focusing on the development of on-line degree programs focused on the development of professional environmental scientists as a means to recruit new students and generate new enrollment revenue. Before these universities can successfully engage in the development of on-line programs, it must understand the challenges of various learning styles and the benefits of on-line learning as a knowledge sharing and knowledge collaboration tool.

What is powerful about the benefits of on-line degree programs is that they allow science professionals that travel extensively or that work in remote locations to have access to professional development degree programs 24 hours a day through accessing the Internet (Junco & Mastrodicasa, 2007). On-line learning can foster the development of national and international learning communities that engage in knowledge development, knowledge collaboration, and knowledge sharing through the development of learning communities of practice. The concept, diverse global community of practice, refers to online communities with diverse organizational members sharing knowledge nationally and internationally through student membership from different genders, ages, races, cultures, and countries (Hildreth, 2004). On-line and e-programs create opportunities for professionals to have access to education through the development of communities (Kamenetz, 2009). These communities of students do not exist in the traditional sense, interacting with classmates through weekly face-to-face class meetings. The implication of these communities is an eclectic and diverse learning environment that benefits from collective knowledge and the broadest range of students, from a variety of ages, industries, backgrounds cities, countries, organizations, and professions.

According to Tapscott and Williams (2008, p. 153), people's ability to collaborate, innovate, and use technology to develop new processes and inventions is often a key driving force behind the kind of developments that keep citizens, businesses, and commerce from languishing. In the past, before the "world became flat" (Friedman, 2007), organizational and community stakeholders operated in closed, individualistic, rigid, inbred, and hierarchical systems where decisions were strategies were developed and implemented in a vacuum absent of peer benchmarking and review. Collaboration and technological innovation are critical to innovative, global, multinational, and knowledge driven economies (Friedman, 2007). Knowledge can build more rapidly within shared and collaborative networks of community stakeholders that use technological innovation to communicate, distribute ideas, benchmark, and share lessons learned from both successes and failures (Brown & Duguid, 2000).

As more universities develop on-line programs it is critical to consider the importance of learning platforms and curriculum development in relation to learning styles. Because on-line programs do not have the benefit of face-to-face lectures, the understanding of learning styles is a critical aspect of on-line program development and delivery especially how it relates to sciences. These universities and professional science master's program directors should understand that everyone has their own "style" for collecting and organizing information into useful knowledge, and the online environment can be particularly well suited to some learning styles and personality needs. For example, introverted students often find it easier to communicate via computer-mediated communication than in face-to-face situations (Diaz, & Carnal, 1999). Also, the online environment lends itself to a less hierarchical approach to instruction, which meets the learning needs of people who do not approach new information in a systematic or linear fashion. Online learning environments are used to their highest potential when there is consideration for the power of collaborative learning which complements many students' learning styles, and independent learners have also found online courses to be well suited to their needs (Diaz, & Carnal, 1999). Because learners have different learning styles or a combination of styles, online educators should design activities that address their modes of learning in order to provide significant experiences for each class participant (Diaz, & Carnal, 1999).

Maddux, Ewing-Taylor, and Johnson (2002) have suggested, for example, that one way to insure quality of online course design and positive student outcomes is through consideration of the relevance of student learning styles to design of instructional methods. Effective online distance education courses should be based on instructional design

decisions that will have the most impact on student learning. These may include decisions related to structure of course delivery, teacher-student communication, appropriate assignments and activities that are conducive to online learning, and effective use of online resources.

Steinbech (2000) illustrated that a consideration of learning styles has always been critically important to teaching and learning. Similarly, researching learning styles of adults in the context of a technology driven learning community can provide awareness of what has to occur to make the learning experience comprehensive and rich for adult students. Knowledge of compatible learning and teaching styles is essential to the development of course content, teaching approaches, and learning assessments. Administrators, faculty members, and course developers that develop a framework of understanding of adult learning styles can influence the impact knowledge acquisition, knowledge transfer, and knowledge application when teaching adult students.

Developing an understanding of adult learning styles is important in face-to-face classroom educational communities in general, but using technology to deliver course content on line adds another dimension and challenge to student success. Mackeracher (2003) outlined that students grasp and retain information more effectively and efficiently when they are taught with methods that match their preferred learning styles. Through the use of particular teaching methodologies geared toward the specific learning styles of adults enrolled in on-line technology driven courses, it may be possible to enhance the learning experiences of adult students. Developing staff, faculty, and organizational dexterity in understanding adult learning styles is critical for colleges and universities that are moving from serving traditional age college students to working adult students (Mackeracher, 2003).

Working adult students or adult learners are not characterized by age but are illustrated by the possession of adult learner traits: self motivation, curiosity about learning, extensive work and life experiences, critical thinking skills, the aptitude to learn in groups, the capability to engage in reflection and introspection, the capacity to engage in self directed learning, and the ability to articulate and apply their perspectives and experiences to course content is what makes teaching them both challenging and unique (Wynn, 2006). Adult learners share similar personas; they approach their learning with dissimilar backgrounds and levels of preparedness (Diaz & Cartnal, 1999; Claxton & Murrell, 1987). In addition, adults connect to their learning experiences based on their learning preferences and learning styles (Claxton & Murrell, 1987). This is similarly true whether adults are learning in a traditional face-to-face classroom or in a technology driven on-line course atmosphere (Buckley & Smith, 2007).

In the best interest of a successful transformation from a traditional classroom based learning community for recent high school graduates to a technology driven learning community offering on-line courses to working adults, it is critical to understand the range of variables and teaching methods that are critical to successfully engaging and connecting to adult students (Diaz & Cartnal, 1999).

As faculty and curriculum developers move from traditional face-to-face classroom environments to technologically driven on-line classroom delivery methods, there must be considerable alteration to learning community teaching and instructional approaches. Gee (1990) outlined several studies that have supported the idea that student engagement and success is positively influenced when teaching approaches are geared towards preferred learning styles. Higher education administrators, faculty members, and curriculum developers should be mindful of the needed alterations to teaching and content delivery that is required when commencing new technology driven environments as a means of entering new markets for students and tuition revenue (Hanna, 1998.)

LITERATURE REVIEW

In terms grasping a clear meaning of learning styles, Merriam and Caffarella (1991) describe learning style as an "individual's characteristic ways of processing information, feeling, and behaving in a learning situation" (p. 176). Diaz and Cartnal (1999) outlined that a learning style is a student's preferred way of absorbing and understanding new information: "It does not have anything to do with how intelligent you are or what skills you possess; it has to do with how your brain works most effectively to learn new information" (p. 130). In synopsis, a student's learning style

is determined by the means in which new data attainment is maximized, retained, and comprehended most successfully (James & Gardner, 1995, p.21).

One of the most influential theorists on adult learning is Malcolm Knowles who developed the concept called andragogy. Malcolm Knowles developed a conceptual framework that distinguishes the key differences between how adults and children learn. His theory of andragogy could be defined as the proficiency and discipline of how adults learn. His theory contrasted with pedagogy, which is the proficiency and discipline of how children learn (Knowles, 1984).

According to Knowles (1984) in the pedagogic model, teachers presuppose the duty for making decisions concerning what will be learned, the method used for learning, and the timing of the learning process. According to Knowles (1984) in the pedagogic model, teachers tightly control all aspects and variables of the learning process. Pedagogy is considered teacher-directed instruction, which places the student in a docile position necessitating deference to the teacher's directives. This methodology for teaching children is based on the supposition that students' minds are like an empty pitcher where the teacher pours knowledge and information into their head. The result is a teaching and learning state of affairs that keenly endorses heavy reliance and dependency on the teacher. In many ways the pedagogical model does not work well for adult learning (Knowles, 1984, P. 43).

According to Knowles (1984), andragogy is based on a number of beliefs about adult learners:

1. As a person matures, his or her self-concept moves from that of a dependent personality towards one of an independent and self-directed person.
2. An adult's collective life and professional experiences are a rich resource for knowledge transfer and learning.
3. The motivations and readiness of an adult to learn is closely related to developmental tasks that include successes and lessons learned from his or her social role.
4. There is a change in time perspective in learning as people evolve and mature in the manner that newly gained knowledge and theory can have the ability to be immediately applied in real world problem solving and analysis (Knowles, 1984, pp. 44-45).
5. The most powerful motivations for learning and the desire for knowledge acquisition are internal rather than external (Knowles, 1984).
6. Adults need to understand the applicability and practicality of why they need to learn something (Knowles, 1984).

In a similar vein to Knowles, Dr. John Sperling (1989) outlined some important theories about how adults learn in relation to younger students and used these principals to develop and create the University of Phoenix. His premise is based on the belief that at traditional universities all knowledge is assumed to reside with the professor, whose job is to transmit it to the passive and inexperienced students. The form of teaching is a faculty lecture where students take notes to prepare for exams where the students are expected to regurgitate back the professors own words on exam as a determination of the student's learning (Sperling, 1989, p. 73). While this method may be acceptable to youthful students with little professional experience, it frustrates and hampers the motivation of working adult students because the methodology discounts the knowledge and experience that they can add to the discussion (Sperling, 1989, p. 73).

"Because of their broad professional work experience, adult learners react with frustration or boredom or antagonism to teachers that have spent their academic lives in a professional cocoon of just being on campus, doing research, and not working professionally in the fields that they teach in. Knowing little of the related professional activities in the professional practice world by the campus walls, and lacking real world reference points, faculty present knowledge of their discipline in an academic vacuum; what is being taught frequently has no application to what is happening in the working world. Applied knowledge is not viewed as important as theoretical knowledge, and there is no requirement to apply theoretical knowledge to the world beyond the academy. Rather than viewing the academic disciplines as tools to solve practical, interdisciplinary problems, professors view mastery of a discipline as an end in itself (Sperling, 1989, p. 73).

Kemp, Morrison, and Ross (1998) outlined that the andragogical model of instruction is heavily focused on presenting methods for assisting students with the acquisition and retention of new knowledge and skills. In this mode, the teacher arranges a set of activities for engaging students with strategies that include establishing a community favorable to learning; devising content that will facilitate education; crafting a blueprint of learning experiences; performing these learning occurrences with appropriate procedures and content; and appraising the accomplishment of learning results and revising approaches as necessary. According to Gibson (1998) a prominent factor in teaching successfully online to adults is making sure that “the learner is, for most part, in charge of what gets learned” (P. 65).

Learning styles are so assorted that no solitary theory can sufficiently tackle in totality the diverse perspective adults bring to a learning community. However this has not prevented theorists from offering their own perspectives to the discussions about the nature and nuances of adult learning styles. This exploration is necessary if universities developing on-line Professional Master of Science degree programs that are the most effective in developing new applied scientists.

Kolb

Kolb's (1985) provided a framework of learning styles and developed the following four categories of adult learning styles: convergers, divergers, assimilators, and accommodators. Convergers collect knowledge by thinking and evaluating and then practically applying new ideas and perspectives. The aptitude to practically apply fresh concepts is this learner's maximum competence. Convergers classify data through hypothetical deductive and logical oriented interpretation (Kolb, 1985).

Divergers acquire new data via their insight and intuition. Individuals with this chosen style of learning draw upon their imaginative competence and their aptitude to observe multifaceted circumstances from a mixture of vantage points and contexts. Divergers also enjoy the ability to effectively amalgamate information into coupled contexts. Divergers' imaginative talent is their utmost learning proficiency (Kolb, 1985).

Assimilators' possess significant capacity to construct theoretical models and critically think inductively. Assimilators learn most effectively by thinking, assessing, reflecting, and planning. Assimilators focus chiefly on the expansion of constructs and theories to a spot that often ignores facts that contradict the foundations of those theories and constructs (Kolb, 1985).

Accommodators, unlike assimilators, will cast off constructs and theories if the facts do not match. Accommodators do exceptionally well in scenarios where they have to apply constructs to a specific state of affairs. Their peak strength is their ability to complete tasks and to become fully involved in fresh occurrences. Accommodators approach problems in an intuitive, trial and error manner, and they obtain information from others rather than from their own critical assessment capabilities (Kolb, 1985).

Kolb's learning model sets out four distinct styles, which are based on a four-stage learning cycle that offers a unique way to understand different learning styles. Kolb believed that the four-stage cycle of learning was a central principle of his experiential learning model. In this cycle the learner goes through the following four emotions: experiencing, reflecting, thinking, and acting. Each of the emotions depends on the next to achieve the optimum experience (Kolb, 1985).

Kolb's (1985) model therefore works on two levels: a four-stage cycle and a four-type definition of learning styles:

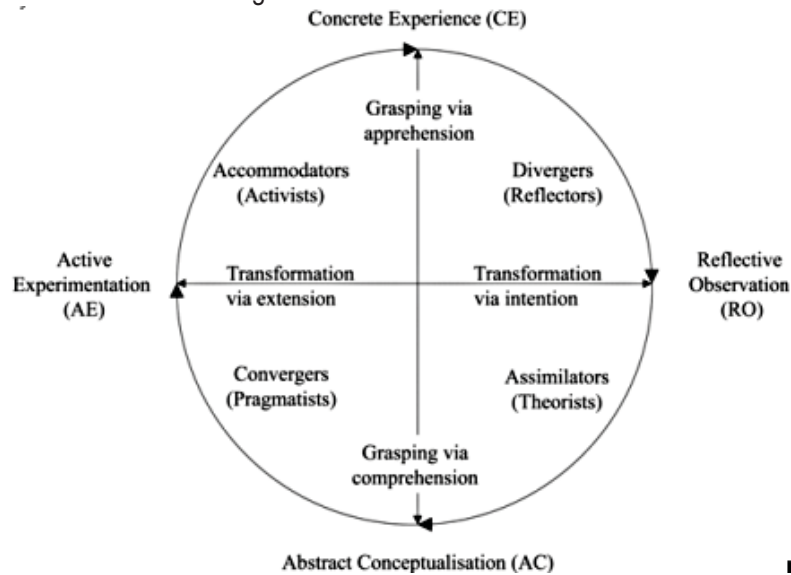
Four-stage cycle:

1. Concrete Experience - (CE)
2. Reflective Observation - (RO)
3. Abstract Conceptualization - (AC)
4. Active Experimentation - (AE)

Four-type definition of learning styles:

1. Diverging (CE/RO)
2. Assimilating (AC/RO)
3. Converging (AC/AE)
4. Accommodating (CE/AE)

And when put together becomes the following model:



Myers-Briggs

The Myers-Brigg personality indicator is based on Carl Jung's learning model. This indicator has been used in educational settings to find the best instructional fit for the adult learner. The results of the indicator are broken down into four personality stages and each stage is broken down into two opposites to create one of 16 combinations (Baron, 1998).

The Myers-Briggs stages are as follows:

Extraversion	Introversion
Sensing	iNtuition
Thinking	Feeling
Judging	Perceiving

The Myers-Briggs combinations are as follows:

ISTJ	ISFJ	INFJ	INTJ
ISTP	ISFP	INFP	INTP
ESTP	ESFP	ENFP	ENTP
ESTJ	ESFJ	ENFJ	ENTJ

The way that the adult learner rates on the stages of Myers-Briggs will determine how they will react in the world. Educators are encouraged to tailor the delivery of the material to the student's identifier because learning will be halted if the delivery is not compatible (Baron, 1998).

Aslanian and Brickell (1980) outlined that adults do not learn for learning sake or the as a check-the-box experience, rather they do so to adapt to change and to be more competitive professionally. The more life changing events that adults encounter, the more motivated they are to seek new learning experiences.

Keefe (1989) outlined adult learning styles into four distinct categories: cognitive styles, affective styles, physiological styles, and interpersonal styles. Cognitive styles relate to receiving, forming, and retaining information. Affective styles refer to attention and motives for learning. Physiological styles refer to learning behaviors related to physical or physiological factors. Interpersonal styles refer to learning behaviors related to social or relational variables. All of these categories contribute to the learning styles of adults in their own respective areas.

LEARNING STYLES AND ON-LINE LEARNING

Instructors need to take learning styles into account due to the fact that technology is part of the educational environment (Buch & Bartley, 2002). The instructor needs to know the learning styles of the students in order to effectively deliver the course content. The instructors also need to utilize a variety of teaching, learning, and assessment methods to enhance new knowledge development (Zapalska & Brozik, 2007). According to Kelly (2006) when it comes to teaching adults, the instructor needs to be flexible and able to adapt the material to real life examples to which the adult learners can relate. There are six factors that motivate adult learners: attitude, need, stimulation, affects, competence, and reinforcement (Kelly, 2006).

Technology is enhancing access to learning for students (Li & Edmonds, 2005). As a result of on-line learning many adult learners are benefiting from being educated through technology (Diaz & Cartnal, 1999). A 2011 study revealed over 6.1 million students enrolled in an online course in fall 2010, a 10.1% increase over the previous year (Lytle, 2011). Data further shows growth in online learning exceeds higher education growth and academic executive's view online learning as an integral part of a universities long-term strategy (Lytle, 2011).

The fastest growing online discipline gaining momentum is healthcare. Business and computer information sciences have also shown an increase in enrollment over the years while education and psychology declined in enrollment in 2010 (Lytle, 2011). The report acknowledged that 67% of academic executives rated the superiority of online learning as being comparable to traditional classroom instruction; an increase from 57% in 2003, when the rating was originally published (Lytle, 2011).

Online proponents posit online learning promotes critical thinking and improves problem-solving skills through discussions, online activities, and instructor interaction (Blake, 2000, as cited in Yang, 2005). The argument is made that online learning also fosters a non-bias learning environment since factors like race or physical characteristics are never present (Palloff & Pratt, 1999, as cited in Yang, 2005).

Based upon research findings the role of the online instructor differs from traditional lecturers. Online instructors become facilitators or mentors. As a facilitator, the instructor must adjust teaching methods to support the new mode of delivery (Ascough, 2002). Information must be selected and dissected to create engagement through thought-provoking discussions (Kettner - Polley, 1999, as cited in Yang & Cornelious, 2005).

Although there are many positives to technology, there has been negative feedback from the introduction of technology to education (Buckley & Smith, 2008). Acceptance of technology in various academic communities has been varied. While some colleges have embraced on-line learning as an innovative wave of the future, others have questioned its value and creditability (Buckley & Smith, 2008). There have been concerns regarding cost and complications of technology as well (Gibson, Harris & Colaric, 2008).

Online opponents also assert the online format is a profit making business that utilizes instructors who have not earned a doctorate degree or failed to implement an instructional design that promotes students' critical thinking (Brown & Green, 2003, as cited in Yang & Cornelious, 2005). Other critics conclude that the online format does not maintain academic honesty. Concerns include plagiarism and cheating (McAlister, Rivera & Hallam, 2001).

Technology is advancing at such a rapid rate that it is a necessity for colleges to stay competitive in their ability to provide educational opportunities to the most diverse spectrum of students. Technology is not cheap and it is tapping into already limited resources of the colleges and universities (Gibson, Harris, & Colaric, 2008). There is a need for better planning and collaboration to stay current with not just technology but the best ways to reach and teach adult students. According to Ascough (2002) for the online system to be effective in teaching students, interaction between student and instructor is critical. Research, discussions, and reflection ensure deeper learning and engagement. Consequently, the instructor and student are accountable for the students' learning outcomes being achieved.

In addition to the business side of education, the academic side has had negative feedback as well (Metzger, 2001). The virtual environment has issues that cause a negative experience for both the instructor and the student. According to Dykman and Davis (2008), the need for consistency, clarity and knowledge are just a few issues that are critical for a virtual environment to work. Deubel (2003) posit the instructors' attitude, level of commitment to the online format, and the instructors comfort with technology are factors that have the potential to undermine a quality virtual program.

CONCLUSION

The growth of new services and products in environmental and biotechnological sciences and the emergence of global environmental health disasters like the B.P. oil spill and the nuclear plant emergency in Japan have increased the need for more environmental scientists. This need for new professionals also comes at a time when colleges and universities are facing shrinking financial resources and limited classroom facilities. On-line learning degree programs and innovative environmental science degree programs have the ability to meet the world's tremendous workforce development needs, assuming that these on-line degree programs are developed with the full consideration of the learning styles of diverse students and adult learners.

Identifying the learning styles of students in an online format resides with the instructor. As a facilitator and mentor, the instructor must intersect with students; adjust his or her attitude to accommodate the needs of the student and the challenges of the online format since online instruction differs from traditional learning. Technology expertise and the ability to create engagement is equally important to ensure the students' learning outcome is achieved.

The Professional Science Master's (PSM) degree is an innovative two-year graduate degree designed to allow students to pursue advanced training and excel in science while simultaneously developing highly-valued business skills. What is powerful about the benefits of on-line degree programs is that they allow science professionals that travel extensively or that work in remote locations to have access to professional development degree programs 24 hours a day through accessing the Internet. On-line learning can foster the development of national and international learning communities that engage in knowledge development, knowledge collaboration, and knowledge sharing through the development of learning communities of practice.

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