The D.P.S. in Computing Program
A View from the Start
and
An Assessment Following Its Fifth Year

Susan M. Merritt
Fred Grossman
Charles C. Tappert
and others
The Doctor of Professional Studies in Computing: An Innovative Professional Doctoral Program was presented at ISECON 2001 in Cincinnati, Ohio.

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Susan M. Merritt is Dean of Pace University's School of Computer Science and Information Systems.

Fred Grossman is Program Chairperson of the D.P.S. Program.

Charles C. Tappert is Associate Program Chairperson of the D.P.S. Program.
The Doctor of Professional Studies in Computing:
An Innovative Professional Doctoral Program

Susan M. Merritt, Dean, smerritt@pace.edu
Fred Grossman, Program Chair, grossman@pace.edu
Charles Tappert, Associate Program Chair, ctappert@pace.edu
Joseph Bergin, bergin@pace.edu
Howard Blum, hblum@pace.edu
Ronald Frank, rfrank@pace.edu
David Sachs, dsachs@pace.edu
Allen Stix, astix@ pace.edu
Stuart Varden, svarden@pace.edu

School of Computer Science & Information Systems
Pace University
White Plains, New York 10606

Abstract

This innovative degree program addresses the inflexibility of traditional doctoral programs for working professionals. Unlike traditional doctoral programs that are often narrowly focused, this program emphasizes integrated study among the computing disciplines as well as applied research in one or more of them. The Doctor of Professional Studies in Computing (D.P.S.), while advanced in content and rigorous in demands, can be distinguished from the Doctor of Philosophy (Ph.D.) in that its focus is the advancement of the practice of computing through applied research and development. The Doctor of Professional Studies is a professional doctorate that integrates academic and professional cultures. The program enables computing and information technology professionals to earn a doctorate in three years through part-time study while continuing in their professional career. The program uses a team approach to both teaching and learning, and combines monthly face-to-face weekend meetings with asynchronous distance learning via the Internet.

Keywords: professional doctorate, computing, part-time doctoral study, asynchronous learning

1. INTRODUCTION

In the fall of 1999, the School of Computer Science and Information Systems (CSIS) of Pace University initiated an innovative doctoral program that enables computing and information technology professionals to earn a Doctor of Professional Studies in Computing in 3 years through part-time study. The project was announced in 1995 (Merritt, 1995), planned and then proposed in 1997 (Merritt, 1997), and approved in 1999 (Merritt, 1999). It was presented at Snowbird in 2000 (Merritt, 2000).

The Doctor of Professional Studies in Computing (D.P.S.) is an innovative post-master’s doctoral program that is structured to meet the needs of the practicing IT professional (Pace University, 2001). Unlike traditional doctoral programs that are often narrowly focused, this program emphasizes integrated study between the computing disciplines as well as applied research in one or more of them. It is an intensive, part-time doctoral program designed for completion in three to four years. The program uses a team approach to both teaching and learning, and combines monthly face-to-face weekend meetings with asynchronous distance learning via the Internet.

Several other universities offer doctoral programs that permit part-time study. For example, Robert Morris College in Pittsburgh, PA offers a Doctor of Science in Information Systems and Communications that is a three-year program (Caputo, 2000; Robert Morris College, 2001). New Jersey Institute of Technology offers a Collaborative Doctorate for mid-career professionals who want to pursue a doctorate while continuing full-time employment (New Jersey Institute of Technology, 2001). The Graduate School of
Computer and Information Sciences at Nova Southeastern University has a doctoral program that combines on-campus/online formats that enable professionals to pursue doctoral degrees without career interruption (Nova University, 2001). However, none of these programs addresses the issues of professional doctoral education in computing as comprehensively as the Pace program does.

This innovative degree program addresses the inflexibility of traditional doctoral programs for working professionals. The Doctor of Professional Studies in Computing, while advanced in content and rigorous in its demands, can be distinguished from the Doctor of Philosophy (Ph.D.) in that its focus is the advancement of the practice of computing through applied research and development. The Doctor of Professional Studies is a professional doctorate that integrates academic and professional cultures.

2. THE CHALLENGE

As we at Pace University's School of Computer Science and Information Systems were planning how to add doctoral education in computing to our graduate degree offerings, one thing was clear from the beginning: we wanted to provide a program that was innovative and responsive to what we believed were the heretofore unsatisfied needs of a substantial group of computing professionals. The vast majority of our master's degree students pursue their graduate studies on a part-time basis and many over the years have asked for the opportunity to pursue part-time doctoral study. It seemed obvious that our program should directly serve this cohort, at least. There are virtually no longer any local doctoral programs that permit part-time study, and the few that do permit part-time doctoral study do not distinguish between the full-time and part-time student. The Council of Graduate Schools reports that full-time study is the norm for doctoral study, especially in the sciences (Syverson, 1999). Although the part-time/full-time issue was one of the major concerns, we decided to address the entire doctoral education paradigm as we created the design of our new program.

Time to Completion

The number of years required to complete a U.S. research doctorate varies by subject as well as by the distinction between total elapsed time and the time during which a student was registered. "The Survey of Earned Doctorates" (NSF et al., 1999) provides the data given in Table 1. The median number of registered years for all fields is just over 7 years. This means that, when added to the average of 4-5 years for a bachelor's degree, U.S. citizens who earn an American research doctorate have spent around 11 or more academic years in school as full-time students and researchers. We believe that this is neither necessary nor good for the student, and our doctoral program is, among other things, designed to address and remedy this time-to-degree issue.

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The Professional Doctorate

The best-known research doctorate title awarded in the United States is the Doctor of Philosophy (Ph.D.). However, there are a number of other doctoral titles that enjoy the same status and represent variants of the Ph.D. within certain fields (U.S. Department of Education).

- Doctor of Forestry (D.F.)
- Doctor of Geological Science (D.G.S.)
- Doctor of Industrial Technology (D.I.T.)
- Doctor of Music (D.M.)
- Doctor of Public Administration (D.P.A.)
- Doctor of Professional Studies (D.P.S.)

All of them have similar content requirements. The following is a subset of the degree titles that the U.S. National Science Foundation (NSF) recognizes as research degrees that are equivalent to the Ph.D. The complete list is in given in the "Report on Postsecondary Education" (U.S. Department of Education).

- Doctor of Fine Arts (D.F.A.)
- Doctor of Health and Safety (D.H.S.)
- Doctor of Library Science (D.L.S.)
- Doctor of Modern Languages (D.M.L.)
- Doctor of Public Health (D.P.H.)
- Doctor of Science (D.Sc./Sc.D.)

A professional doctorate is aimed at practicing professionals who wish to acquire formal qualifications in recognition of research and research-related activities that they carry out in their work. Technological, economic and societal changes contribute to the changing nature of professional practice. Professionals must be able to keep up with the state of their practice by playing a role in the development, management and evaluation of professional activity; and responding creatively to the challenges of change. This is especially true in the emerging computing and information technologies.

For some professionals, it is appropriate to undertake the study of specific topics in depth, with the intention of contributing new theoretical knowledge and methodological approaches. There are many doctoral programs that offer the opportunity for this kind of study leading to a Ph.D. However, other professionals want to develop a different expertise and contribution. Their concerns focus on being able to:

- develop knowledge and expertise in relation to different forms of research and research topics
- learn how to enhance their practice through varied but systematic research inquiry
- appreciate how policy-making and management may be furthered through research activity
- develop the knowledge and skills required to support the research of others
- disseminate research findings, theirs and others, to professional and research audiences

We have designed a professional doctorate with these goals that also fosters explicit links between research and professional practice and development. The D.P.S. in Computing at Pace University provides a framework in which significant applied research is integral to all coursework in the curriculum. Moreover, we treat doctoral education holistically. We serve the total learning needs of the doctoral student.

3. THE STRATEGY AND IMPLEMENTATION

Many of the difficulties that students face in the doctoral education experience affect both full-time and part-time students. However the effect on the part-time student is generally much greater. Full-time students often perceive that they are isolated from their student peers and the faculty, but for part-time students this is usually a reality. Full-time students complain about the amount of work and study time. But for the part-time student who is maintaining a professional career and a family life, finding the necessary time for serious doctoral study can be insurmountable. For a part-time student, the time-to-completion is an even greater issue than it is for the full-time student.

As we considered strategies for overcoming these difficulties, we quickly recognized that many of the things that can interfere with successful study in a full-time doctoral program can be turned into benefits in a properly designed program for the part-time student who is a full-time employed computing and IT professional. The goal was to provide an intellectually stimulating learning environment in which the cutting-edge and emerging computing and information technology can be discussed, debated and researched by all students and faculty.

The D.P.S. program exploits the rich diversity in student backgrounds and professional experience of the doctoral student body. Students in the program have deep expertise in specialized areas of computing and IT as a result of their professional lives. The program utilizes team-teaching/team-learning supported by an intellectually nourishing learning community. Community building begins with the first on-site session.
and continues to grow throughout the program. We attribute the program's virtually 100% retention to this strong and supportive community of students and faculty. (One student in each of the first two classes withdrew early in the first semester due to excessive professional and personal demands.) The community operates as an open society in which everything is shared, assignments and presentations are published on the web and are available to all. Students and faculty are encouraged to share everything that they do or think about.

In order to maintain this learning environment, the program depends heavily upon the Internet, building upon the experience of the School of Computer Science and Information Systems (Blum and Sachs, 1999; Merritt, 1999) We utilize various software and communication modes to support the necessary student-student and student-faculty interaction. The main courseware for the program is CourseInfo (now Blackboard 5 http://blackboard.com). For information dissemination and general asynchronous discussion we use a number of listservers. For synchronous discussion we use Blackboard chat and Instant Messaging (AOL AIM). One of the most successful modes for asynchronous discussion is the "wiki". A wiki is a completely interactive web site at which any visitor can edit any page. Such a site can be used to broadcast information to students, to permit threaded discussions on-line, and to get anonymous feedback from students throughout the course. Wiki (wiki wiki web -- a play on quick web) was invented by Ward Cunningham. The premier site is at http://c2.com/cgi/wiki. This is the world wide virtual meeting place of the patterns community.

The D.P.S. in Computing program admits part-time students who wish to participate in doctoral study while maintaining a professional career. We seek students who can devote frequent and substantial time to doctoral study, who have an independent learning style, and who are self-motivated and self-disciplined. Students are required to have earned a master's degree in computing/information technology, or a master's degree in a closely related field and have very strong technical professional computing experience. Generally our students are required to have 5 or more years of advanced professional information technology experience.

Each fall we admit a class of about 20 students who are expected to graduate as a class after three years. To emphasize that this is a three year program, we identify and refer to a class by its expected graduation date, e.g., the class that entered in fall 1999 is referred to as the "class of 2002." Each class proceeds through the program as a cohort in lock-step fashion. There is an online orientation for new doctoral students before classes begin and an initial on-site 4-day first week (including a weekend) to get things started. Regular on-site sessions occur monthly, five times a semester, on Friday evenings and all day Saturday. In between the on-site sessions, students and faculty interact energetically over the Internet.

Research and the Dissertation
Traditionally, the single most important and difficult component of doctoral study is the dissertation. The long times-to-completion are primarily due to a student not being able to complete the research in a timely manner. Both full-time and part-time doctoral students suffer from the "All But Dissertation (A.B.D.)" syndrome. We have addressed this issue and believe that we have a solution. D.P.S. students focus on research beginning with the first semester of study with the guidance of an advisor and through the research seminar. The primary purpose of the five-semester Research Seminar sequence is to prepare the students for their doctoral research. The seminar sequence begins with a gentle introduction to what research in computing and information technology is about, utilizing examples of different kinds of computing research and methodologies presented by faculty and invited researchers. The seminars progress by having students investigate various research areas of their own interest, ultimately culminating with a dissertation proposal draft by the end of the second year of study. An important ancillary benefit is that as the students progress through the seminars, they are exposed to important emerging issues in computing and information technology.

These seminar courses provide the student with an opportunity to get to know and interact with the Pace CSIS faculty. To facilitate the dissertation process, this research seminar helps students develop skills that can be used in the dissertation process, such as information gathering, problem identification, investigation and analysis, effective documentation, planning, and management. In many cases, these research seminars help lay a direct foundation for a dissertation or indirectly stimulate interest in an area that ultimately leads to a dissertation. Thus the program has built-in coaching and mentoring by faculty advisors and most importantly, by the students themselves.

4. STUDENTS

There is a great deal of professional diversity among the D.P.S. students. The organizations that employ our students include Bell Atlantic, IBM, Lucent, Hyperion Solutions, Computer Associates, Met Life, New York Life, Chase, Philips Research, AT&T, AARP, E*Trade, Oracle, U.S. Military Academy (West Point), PriceWaterhouse-Coopers, and AXXA. The average professional computing and IT experience is about 18 years and ranges from 6 to 43 years. Students' professional activities include software development, telecommunications management, data management, and e-commerce, and the job titles include CIO, Vice President, and Director of e-business.
Many of our D.P.S. students live and work in the extended New York metropolitan area, but we have students who travel from California, Washington D.C., Philadelphia and Boston. Geographic distribution is a goal, facilitated by the use of the Internet and scheduling strategies.

Women make up 20% of our first two classes. This matches the U.S. average as given in (Caputo, 2000 & NSF et al., 1999). However, our new class of 2004 will have 50% women. The race/ethnic breakdown in our first two classes is shown in Table 2 in comparison to U.S. doctoral student data provided in the "Survey of Earned Doctorates" (NSF et al., 1999).

Table 2
U.S. citizen/permanent resident doctorate recipients by race/ethnicity, 1999

<table>
<thead>
<tr>
<th>Field for Doctorate</th>
<th>Total</th>
<th>Asian</th>
<th>Black</th>
<th>White</th>
<th>Hispanic</th>
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<tr>
<td>Computer Science</td>
<td>385</td>
<td>74</td>
<td>10</td>
<td>288</td>
<td>13</td>
</tr>
<tr>
<td>Information Systems</td>
<td>81</td>
<td>12</td>
<td>8</td>
<td>60</td>
<td>1</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>18</td>
<td>4</td>
<td>1</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>Computer Engineering</td>
<td>92</td>
<td>31</td>
<td>5</td>
<td>56</td>
<td>0</td>
</tr>
<tr>
<td>Management Information Systems</td>
<td>57</td>
<td>6</td>
<td>2</td>
<td>47</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>6333</td>
<td>127</td>
<td>26</td>
<td>462</td>
<td>18</td>
</tr>
<tr>
<td>U.S. %</td>
<td></td>
<td></td>
<td></td>
<td>20%</td>
<td>18%</td>
</tr>
<tr>
<td>Pace D.P.S. in Computing (combined classes 2002 &amp; 2003)</td>
<td></td>
<td></td>
<td></td>
<td>28%</td>
<td>18%</td>
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</table>

The dissertation areas in which the students in the class of 2002 are working include: Data Warehousing, Patterns and Pattern Languages, Visualization of Data, Genetic Algorithms, Distributed Systems Architecture, Software Component Integration, Website Personalization and Privacy, Buyer and Seller Recommender Systems, Software Testing and Quality Assurance, Data Security, Web Content Management Strategies, Web Services for Businesses, and Broadband Wireless Network Access Services.

5. CURRICULUM STRUCTURE

The D.P.S. in Computing is a 48-credit program, which assumes the prior completion of a master’s degree in computing or a closely related discipline. Research commences in the first year when students begin an 18-credit integrative core, and continues through the 12-credit advanced elective sequence in the second year. A 12-credit dissertation completes the program.

The first year (fall, spring and summer) integrated core curriculum is designed to provide an understanding of computing as a coherent discipline and the environments in which computer-based systems operate. In the second year (fall and spring), students pursue elective study in selected areas that support the projected dissertation research. Students devote the third year to completing their research and writing the dissertation.

Students participate in a Research Seminar sequence during each of the five semesters of the first two years of study (including summer between the first and second years). These seminar courses introduce the student to the various methods and styles of computing research. Students will identify new computing research problems and formulate research proposals in preparation for their dissertation research. These courses provide the student with an opportunity to get to know and interact with the CSIS faculty.

Course Descriptions
First Year of Study
Software Design and Implementation DCS 801, 802, 803 2 credits each
These courses address the environment in which software systems are built and used. Critical and emerging issues in computer science and their relationship to software development and design provide the major theme. These courses are project based, and students develop a substantial project working in small teams. The project is coordinated with the DCS821, 822, 823 courses. The project development explores cutting edge object-oriented software development methodologies such as extreme programming (XP), open source and mob software, and is implemented in Java. Pattern-oriented software architecture as an approach to software development is explored.

Topics include:
Object-oriented development and Java; design patterns; Unified Modeling Language (UML); GUI programming; computer ethics and social values; human computer interaction; software standards; distributed systems; client server computing; Internet programming; emerging software methodologies.
Systems Development—Analysis, Design, and Engineering DCS 821, 822, 823 2 credits each
These courses are project based. Students develop a substantial project working in small teams coordinated with the DCS801, 802 and 803 courses. The project development explores cutting-edge software systems development methodologies. Contact is practice-oriented software engineering and information systems, and is representative of the real-world environment with which practicing computer professionals interact -- tool-rich working environments, team development efforts, cost performance trade-offs in business contexts, and expenditure of considerable effort on tasks other than source-code development. 
Topics include:
Problem solving paradigms; the software engineering problems of scale, cost, schedule, quality and consistency; software development process; organizational patterns; analysis patterns, design patterns and generic models; object-oriented architectures; object-oriented analysis & design; software process -- processes, projects, process improvement; software process assessment -- capability maturity model (CMM), ISO 9001; software quality assurance; project management; risk management; user-interface design issues; GUI design; software maintenance; software reuse.

Data Communications, Networking, and Internet DCS 833, 834, 835 2 credits each
This course sequence progresses from the basics of data, signals and information transmission to principles of computer networking and the operation of current and evolving Internet protocols and applications. Material provides a foundation for planning and management of network facilities and design and implementation of Internet-based applications. The first course establishes a foundation in data communications as a major component of current and evolving telecommunications systems and the Internet. Students see Internet-related examples. The second course builds upon the first, examining in detail the issues and techniques for computer networking emphasizing LANs, internetworking via TCP/IP, and the Internet. The ISO Reference Model and the TCP/IP protocols form the framework for introducing Internet facilities, services and applications. In the third course, students examine current and emerging Internet services, protocols and applications. Students investigate and report new network technologies and applications in small team projects. Concepts related to Internet-based applications and the Web are applied in the core-curriculum software development project.

Topics include:
Models of communications and layered architectures; analysis of data, signals and transmission capacity; digital voice and video; link protocols and error control; multiplexing and statistical sharing of network resources; probability models of network traffic; LAN strategies and standards such as shared and switched Ethernet, FDDI and ATM; LAN internetworking using bridges and routers; routing strategies and congestion in networks; the IP protocol; transport layer strategies and the TCP and UDP protocols; HTTP and the WEB; Domain Name System, FTP, and SNMP; security and e-commerce; multicasting; multimedia, quality of service (QOS) protocols; Internet telephony (VOIP).

Research Seminar DCS 891A, B, C, D, E 1 credit each (*2 credits)
Students are introduced to the methods and styles of computing research through presentations by faculty and industry professionals and by studying selected research documents. Students see a variety of methods and styles of computing research. Students learn to identify new computing research problems and to formulate research proposals in preparation for dissertation research.

Second Year of Study
Topics in Computing and Information Technology DCS 860, 861 2 or 3 credits each (6 per semester)
These courses consist of topics of current interest to students. Cutting edge issues and emerging information technology areas are explored. Students register for two or three topics per semester. The topics for these courses are in large part selected by the students. A major goal for these courses is to understand the technological life cycle, the various emerging information technologies covered, their issues and potential impact. The program calls on the computing community of the nation for visiting experts who discuss their current research and development activities.

Topics include:
Small computing devices -- communicating with computers in human modalities, pen computing and handwriting recognition, speech recognition techniques and applications; data security -- cryptography, intrusion detection, corporate vital defense strategy; Internet performance and high-volume web serving technologies; data mining and data warehousing; e-commerce issues; pervasive computing and m-commerce, XML, VoiceXML, WML and WAP, human computer interaction, and natural language processing; emerging telecommunication technologies; distributed components and middleware; user interface development environments and tools; artificial intelligence, and virtual reality.

Third Year of Study
Dissertation for Doctor of Professional Studies in Computing DCS 990, 991 6 credits each
The dissertation is an original, rigorous, independent applied research product that may advance knowledge, improve professional practice, and/or contribute to the understanding of computing. Research methods used depend upon the nature of the research: controlled experiment, project development, empirical studies, theoretical analyses, or other methods as appropriate. The dissertation must be of sufficient strength to be able to distill from it a paper worthy of publication in a
refereed journal or conference proceeding, or to use it as
the basis of a monograph. Although publication is not a
requirement for completing the doctoral degree, students
are required to prepare a paper to submit for publication.

6. PROGRAM ASSESSMENT

The traditional doctorate presumes full-time study,
emphasizes specialization, aims to create theoreticians,
and almost always engenders feelings of personal
antipathy. Our program strives to be dramatically
different. It is designed for the working professional,
emphasizes study across the disciplines of computing,
aims to cultivate applied expertise, and is committed to
both responsiveness to students and timely student
graduations. Furthermore, it is more interactive than
traditional programs and relies upon online courseware
and the Internet.

Because the program is at the educational frontier,
assessment is critical. Objective data needs to be
collected to verify the program's efficacy. Novel ideas
that are working need to be recognized and cultivated.
Shortcomings need to be pinpointed and addressed
before too much learning time is lost or students
experience angst.

Three substantial assessments are performed at the end
of each semester: (i) individual course evaluations, (ii)
an extensive survey with both closed-ended and open-
ended questions about overall program experiences, and
(iii) an in-depth questionnaire for teaching faculty. In
addition, special activities and events such as the
summer workshop on Java, an evening of semi-formal
and informal interaction between the students and the
entire CSIS faculty aimed at building dissertation
committees, and retreats where students receive help
with their dissertation research formulations are
promptly followed by assessments.

The assessment results have been strongly favorable,
which is consistent with our virtually one hundred
percent student retention rate. The ultimate program
assessment will come between June and December of
2002 as we see whether or not students are completing
their dissertations within the intended timeframe and
whether their work is met with external commendation.

7. CONCLUSIONS

During the course of this doctoral program, we have
found that the students:
- integrate the academic and professional
  aspects of computing
- apply what they learn to their professional
  environment and to their aspirations for the
  future

We are finding that all of these accomplishments
enhance their marketability as highly skilled and
experienced IT professionals, and, upon completion of
this journey, we anticipate that our students will emerge
as leaders in the IT fields.

8. REFERENCES

Blum, H. and D. Sacha, December 1999, "An
Asynchronous Distance-Learning Course in Data
Communications and Networks", SIGCSE Bulletin, Vol
31, No. 4, pp. 52-55.

Caputo, D.J. and F.G. Kohun, November 2000,
"Designing undergraduate and doctoral level programs
to advance the career potential of women in information
technology", Proceedings ISECON 2000, Philadelphia,
PA.

Merritt, S., Fall 1995, “Message from the Dean: The
CSIS Doctoral Project,” CSIS Communiqué, Pace
University.

Merritt, S., September 15, 1997, Proposal to the New
York State Education Department from Pace University
School of Computer Science and Information Systems
for Doctoral of Professional Studies (D.P.S.) Program in
Computing Studies.

Merritt, S., Spring 1999, “Message from the Dean:
Innovative Doctoral Program,” CSIS Communiqué,
Pace University.

Merritt, S., October 1999, “Moving ALN to the
Mainstream,” 5th International Conference on
Asynchronous Learning Networks, College Park, MD.

Computing,” IT, Informatics & Computer Science, CRA
Biannual Meeting, Snowbird, UT.

New Jersey Institute of Technology, 2001,
http://www.njit.edu

Nova University, 2001, http://www.scis.nova.edu

NSF et al., 1999, "Doctorate Recipients from United
States Universities: Summary Report 1999, Survey of
Earned Doctorates", sponsored by NSF, NIH, USED,
NEH, USDA, NASA

Pace University School of Computer Science &
Information Systems, Doctor of Professional Studies in

7


Developing a Professional Doctorate in Computing: A Fifth Year Assessment

Susan M. Merritt, Dean, smerritt@pace.edu
Fred Grossman, Program Chair, grossman@pace.edu
Charles C. Tappert, Associate Program Chair, ctappert@pace.edu
David A. Sachs, Associate Dean, dsachs@pace.edu

School of Computer Science & Information Systems
Pace University
White Plains, New York 10606

Abstract

Pace University's Doctor of Professional Studies in Computing program, a fusion of academic and professional cultures, started as a venture into largely uncharted educational territory. One part of the mission was and remains a one hundred percent student retention rate, with each student successfully defending a dissertation with original research in three years. Yet, throughout, the students retain full-time employment as high-level computing and IT professionals.

Another part of the mission is to provide breadth and currency across the computing disciplines (specifically, computer science, information systems, and telecommunications) as well as depth in annually selected areas of emerging technology. This is in a context in which entering students have masters degrees and generally at least five years of professional experience in diverse computing-related areas and therefore lack a common foundational background.

As a new program at the University and in the country, penetrating assessments have been conducted each semester. This report describes the assessments, the anticipated and unanticipated challenges, and the steps that have made the evolutionary development of this program successful.

1. Introduction

The Doctor of Professional Studies in Computing (D.P.S.) can be distinguished from the Doctor of Philosophy (Ph.D.) in that it focuses on the advancement of the practice of computing through applied research and development, promotes study of the computing disciplines in an integrated manner, and is structured for completion by working IT professionals in three years of continuous, part-time study. The program uses a team approach to both teaching and learning, and combines monthly face-to-face
weekend meetings with asynchronous distance learning via the Internet. Each September, beginning in 1999, a new class of approximately twenty students matriculates. Classes move through the program as a cohort.

The chief educational objective is that practicing information technology professionals will encounter and develop insights into recent developments within the fields contributing to applied computing, in an educational and research setting. One goal is that students will be able to apply some of what they are learning immediately on their job. Sometimes the utility is concrete; other times it is more abstract, for example, in the way they think about problems. The other chief objective is that each student will become able to undertake the creation of new knowledge and the know-how to report research results to academic and professional audiences.

The D.P.S. in Computing admitted its first cohort class of twenty students in the Fall of 1999. Residency consists of five consecutive semesters of coursework: the fall, spring and summer semesters of one year, and the fall and spring of the following year. Thereafter, energies are applied to the dissertation. During residency, on campus classes are held roughly once a month, on a Friday evening and all day Saturday. When students are not on campus a great deal of activity takes place through Internet courseware (Blackboard), email lists, the Wiki Wiki web, instant messaging, and, when needed, telephone conferences.

A special strength of the program is the specialized technical knowledge and expertise in the students’ professional computing and IT experience. A learning-teaching community is created at the very beginning which draws heavily upon this expertise and strengthens the collaborative skills of the students. These abilities and skills are harnessed for collective advantage in three ways:

i. At orientation and onward, it is emphasized that the spirit of the program is one of community and mutual assistance, not competition. Each class moves through the sequence of courses as a cohort that is expected to remain intact.

ii. Every opportunity is used to promote student-student, student-faculty, and faculty-faculty congeniality and students are encouraged to post technical questions on things that came up on the class email lists.

iii. A team-based software development project comprises a substantial part of the class work during the first two semesters.

Every indicator confirms that a very high level of cohesion grows quickly and persists. In fact, this strong sense of community may be credited for the retention of several students who, at different points, felt overwhelmed by the pressures of school and work.
A full discussion of the beginnings of the Pace University DPS in Computing, its curriculum, and mission may be found in [1]. As of this writing, the sixth entering class is beginning its first year, and three classes have completed their third year milestone, when dissertations were to have been defended. The basic student demographics, the curriculum, and the structure of the program have not changed. Yet, there were issues to be addressed as the program moved along and adjustments were made accordingly. This paper describes some of these and the assessment tools and procedures that enabled this to happen.

2. Five Thrusts of Assessment

Assessment involves empirical investigation into the effectiveness of a goal-oriented activity and using the results to enhance procedural efficacy. As a form of social research, an investigation's conduct depends upon how much is understood about what is going on. When an activity's mechanisms are well understood, the operative variables and their relationships are known. This makes possible short-answer questionnaires. In contrast, open-ended techniques are needed for trailblazing into the factors that promote or inhibit the activity's success. Items that elicit prose are used for evoking insightful reflection. Many short-answer and open-ended instruments were created for assessing the DPS. Because the students are stakeholders in the program, and are articulate, their best efforts as survey participants could be relied upon.

Course Evaluations
An opinion survey is administered in every course at the end of a semester. This includes the usual complement of queries on the clarity of course objectives, the fairness of work evaluation, and the appropriateness of the workload. Customized items pertain to whether appropriate content was selected for emphasis, whether coverage was at the appropriate depth, and whether students felt adequately prepared. Other customized items pertain to the value of collaborative work and the courseware. With thoughtfulness primed by over twenty short-answer items, students are asked to remark on what they found most valuable about the course and for suggested improvements.

Semester Reflections on the Program as a Whole
The first two years of the program has a mix of courses and objectives that give each semester a distinctive flavor. Object technology and emerging software design and development methodologies (e.g. agile programming) figure prominently in the first semester. Milestones associated with the dissertation become overriding concerns in later semesters. These milestones include drafting an idea paper, performing a review of the literature, devising a method of investigation, and selecting an adviser. A thorough look at the satisfactions and frustrations of studentship along with the program's content, structure, and procedures needs to reach beyond the individual courses. Thus, at the end
of each semester, students receive an open-ended questionnaire on their progress. The faculty members are queried on the same concerns with a questionnaire that takes their perspective.

**Special Purpose Questionnaires**

Student progress is accelerated by procedures intended to facilitate processes that are slow moving in traditional doctoral programs. The process of locating a dissertation adviser, for instance, is streamlined by a number of mechanisms, including events where faculty members introduce themselves and their research interests. Inventive procedures invariably look promising, but a factual answer is needed to the question of how well do they really work. If a procedure works, it should be replicated. What can be done to improve its effectiveness? Will a follow-up be planned, and, if so, what form will it take? Questions like these are the subject of specially focused assessments.

**Examinations of the Dissertation Process**

The dissertation process includes all activities during the five semesters of residency that cultivate an understanding of research, lead to the formation of a committee, and establish a plan of action for the third year. It includes all activities during the third year that contribute to progress, such as the three class meetings during the fall semester and the three class meetings during the spring semester at which each student presents a progress report and receives both support and constructive criticism from peers and faculty. The dissertation process also includes the continuous communication offered to students who have missed the three year completion date but continue to work on their research (in some cases, slowly). One of the program's objectives is that there will be no ABD's. We consider a student as to be ABD when she or he is no longer actively working on the dissertation. Efforts are expended to prevent this.

Numerous special assessments have been conducted on the dissertation process. One is on whether students are, in fact, leaving the fifth semester with preparedness to complete. Another addresses the schedule slippage occurring during the summer trailing the end of residency. A series of questionnaires adduced data on the kinds and amounts of interaction taking place between students and dissertation advisers.

**Evaluations of Dissertation Quality**

Academic quality is a transcending issue. The value of a degree to a student, the value of an education to a sponsoring organization, and the value of a program to a university depend upon it. One might legitimately wonder how credible the dissertations produced by working professionals within three years of entering a doctoral program (albeit a post-masters program) appear to faculty accustomed to Ph.D. theses from traditional programs. To this end, objective reviewers were selected and asked to evaluate the meaningfulness of the problem, the methodological strength of the investigation, and the readability of the presentation.

Findings from assessment investigations are put to three uses: program improvement, "real-time" quality control, and accountability. Program improvements are adaptations that will strengthen the curriculum, its delivery, procedures, and the success of future students. An example is the Java workshop offered as a free option ahead of the first semester. "Real-time" quality control refers to remedies that compensate for faults effecting students within the program; a problem is identified and a correction is installed before the problem results in an immutable diminishment. Accountability pertains to findings that substantiate the program's value. Holding these uses in mind when reviewing a report helps to clarify expository intents that may be murky.

The dissertation is what distinguishes a research doctorate from other graduate degrees. It is the program's capstone and also the greatest challenge for the students [2]. Therefore, findings pertaining to the dissertation process and the quality of dissertations emerging from the D.P.S. are described here in some detail.

The Dissertation Process

For each class up through the class that started last fall (Fall 2003), the retention rate through the five semesters of coursework has been just one or two students shy of 100%. As of September 2004, defenses are emerging from the third entering class (the cohort that started in 2001). Because Pace University's D.P.S. in Computing is unique and new, no baselines exist for pronouncing the dissertation completion rate to be high or low. For the first class, from which graduations began in May 2002, 13 (65%) of the 20 students who originally matriculated have received diplomas; five of the seven who did not graduate report that efforts are continuing.

Although a graduation rate of 65% within five years may be commendable, it is disappointing that 35% of those with the diligence to complete the coursework failed to complete within two years beyond the targeted three-years. To obtain a thorough understanding of the obstacles, and why different ones pose problems to particular students, a sweeping investigation was conducted in May 2004 involving all who graduated, all who did not graduate within four years (we term this aggregate the non-graduates), all those in the midst of their third (or fourth) year, and all dissertation advisers.

Apart from job stress, job loss, or illness; the problem identified as most severe by both the faculty and the non-graduates was leaving for the summer, following the five years of residency, without a clearly defined research topic. This could happen in two ways. There may be an explicit void, of which the student is only too aware; or the student might believe an agreement on the problem and the methodology that exits with the adviser, in fact, does not.
All respondents believe that more needs to be done, earlier, to steer students in the direction of individually suitable research topics. Sufficient time needs to be available for false starts and for putting the research on a solid footing before residency elapses. This was apparent before its objective confirmation by the latest assessment and, already, an attempt has been made to improve the program. The dissertation "idea paper," a semi-formal proposal, is now due during the third term of residency (i.e. the summer between years one and two) instead of during the fourth term.

It had been thought, when the program was under development, that dissertations would be rooted in students' professional background and practice. When this is the case, students tend strongly to be successful in completing their research expeditiously. However, for more than half of the students, this is not the case, and both finding a topic and bringing the research to a successful conclusion is more difficult. An impediment to pursuing research matched to one's background may be the disinclination of advisers to extend themselves as partners, studying and working along with the student. A faculty member contributed this observation. It was echoed by students who felt that feedback was slow in coming and of limited utility when the research was in an area that did not coincide with the adviser's. A step toward improvement may be increasing the number of faculty members actively engaged in the program to enlarge the domain of faculty interests. Yet benefits are seen to accrue when students are relatively autonomous, such as able to change advisers (even quite late in the work) with no ill effects.

Student after student reports on the value of subdividing research and dissertation work into manageable pieces. One faculty member has adopted a strategy of "encouraging the student to produce a paper for publication, even if only for an internal workshop, soon after obtaining preliminary results." This provides a foothold into describing the problem, the research method, and the findings. It would seem that encouraging students to establish a sequence of achievable milestones promotes success.

Graduates credit their resolve, above all else, with the successful completion of their dissertation. Perhaps this is key inasmuch as a non-graduate warns of "getting caught going back to our regular lives and not being able to spend enough time on the research." Faculty members similarly warn of the slow drift that can carry students away. The cohort completing its third year (i.e. the class beginning in September 2001) kept up its resolve and morale with online chats. Discussion focused on writer's block, progress reports along with research hints (e.g. "What worked for me...."), and useful URLs. Staying in touch, the positive tone, and smatterings of humor helped to counter feelings of being overwhelmed and alone.
Evaluations of Dissertation Quality

A rigorous inquiry on dissertation quality substantiates their caliber. Evaluators with standards normed to programs conferring Ph.D.s rated those dissertations considered best to be as fine as theses seen anywhere. The dissertations representative of the spectrum's bulge in the middle were unquestionably worthy. The dissertations considered weak were likewise branded as weak (although acceptable), substantiating the investigation's validity. On a four-point scale with the highest mark being a 4.0, dissertations rated as follows:

- significance of the problem -- 3.4.
- strength of investigative methodology -- 3.3.
- readability -- 3.5.

The comments rightly note that DPS dissertations carry a decidedly applied orientation. For example, a dissertation on building artificial neural networks for analyzing turbulence in fluid flow through pipes dwelled more on the construction and efficacy of the new technology than on abstract characteristics of dynamic (nonlinear) systems. This is expected and understandable inasmuch as the D.P.S. is oriented toward the concerns of practitioners, which are more likely rooted in application than theory.

By the end of May 2004, the cohort that had begun in Fall 2001 had defended a total of six dissertations with the following titles:

*Optimized Software Component Allocation on Clustered Application Servers*

*Measuring Usability: Categorically Modeling Successful Sites Using Established Metrics*

*Stego-Marking Packets to Control Information Leakage on TCP/IP Based Network*

*Solving a Class of Time-Dependent Combinatorial Optimization Problems with Abstraction, Transformation and Simulated Annealing*

*Solving Optimization Problems Using Genetic Algorithms with Multiple Genome Coding*

*Architectural Solutions to Agent-Enabling E-Commerce Portals with Pull/Push Abilities*

4. Conclusion

A cliché of today might be that assessment is a journey, not a destination. The process is never done. Subsequent to an improvement, a study is needed of its efficacy and unanticipated effects in search of the next improvement. Or, another concern emerges as a priority. The point is that each improvement is provisional (or assumed to be one in a sequence), and no one improvement brings program scrutiny to a close. This is a benefit because no program repair or upgrade needs to be without fault.

A danger of describing a program by way of assessment is that a focus on improvements made and still needed highlights defects more than strengths. By all indicators, Pace University's D.P.S. in Computing at five years of age is a success. That a full class is admitted each year from a growing pool of applicants, confirms that it is meeting a need. That students are graduating, and their dissertations are good, confirms the effectiveness of the processes. A robust sense of community is a source of program strength and a special asset for all involved. Students work proactively with each other, and with faculty, and faculty work with each other, to achieve success for all students. Alumni speak of having formed life-long friendships and have maintained professional relationships with the faculty and the School. They continue to co-author papers with faculty members. They serve on dissertation committees. They teach for Pace as adjuncts. They attend the annual DPS picnic. And they contribute generously to the School's scholarship fund.

5. References


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Allen Stix  
School of CS & IS - Goldstein Academic Center  
Pace University  
861 Bedford Road  
Pleasantville, NY 10570-2799