USASBE APPLICATION—2006

Nominated Pedagogy: Technology Entrepreneurship

Award Category: Innovative Entrepreneurship Education Pedagogy

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Name of Nominated Pedagogy: *Technology Entrepreneurship*

Purpose of the *Technology Entrepreneurship* **Pedagogy:**

The *Technology Entrepreneurship* pedagogy was created in 1998 as a *program-wide pedagogy* to help graduate students learn the principles, fundamentals, and skill sets necessary to initiate and develop successful new ventures focused on novel and unique technologies in the Life Sciences, information technology, telecommunications, or any field where technology is a critical component.
In addition, the pedagogy was formulated and developed for the needs of various other stakeholders, including:
- the interest of University and community research investigators in the commercialization of new intellectual property and technologies which require:
  - Assessment of the intellectual property and technologies on technical merit,
  - Assessment of commercialization potential of the intellectual property or technology,
  - Recognition of, and compliance with, the pertinent regulatory and quality assurance issues,
  - Business opportunity assessment prior to development of a business plan for new venture formation,
  - Determination if new venture formation was the optimal vehicle for technology commercialization;
- to educate, assist, and focus the University faculty and Tampa Bay community on the requirements of, and potential for, effective technology commercialization and product development;
- to assist the University and Tampa Bay community in the identification of technologies and products developed within the University and Tampa Bay area for commercialization and new venture formation.

The *Technology Entrepreneurship* pedagogy was developed to integrate these goals in *a single program and curriculum with strong consistent learning threads,* utilizing an inter-disciplinary, graduate level curriculum and format. The pedagogy was designed to allow science, medical, engineering, business, and legal graduate students to work in inter-disciplinary teams, in conjunction with University and community investigators and entrepreneurs, under the direction and supervision of an inter-disciplinary faculty (business, engineering and science/medical) with significant professional experience as academicians, practitioners, and entrepreneurs in their respective fields.

Primary Objectives of *Technology Entrepreneurship* **Pedagogy:**

The goals and objectives of the program-wide *Technology Entrepreneurship* pedagogy have been to assist students and other stakeholders in the development of *an in-depth understanding and knowledge of*:

- Technology and Life Sciences Business,
- Strong Capabilities in Multi-disciplinary Team Building and Team Management,
- Processes necessary to promote and sustain Innovation in Technologies,
- Opportunity and Strategic Market Assessment,
- Principles and Techniques of Intellectual Property Management,
- Technology Licensure and Commercialization.
- Principles of Regulatory Compliance and Quality Assurance,
- New Product Development,
- Business Planning Skills and New Venture Formation,
- Requirements and Techniques for New Venture Financing,
- Corporate Ethics and Bioethics.

Secondary Objectives:
- Development of a *program-wide pedagogy* with strong, consistent *learning threads* throughout the program,
- Assist the University and community in technology transfer and commercialization—both in licensure opportunities and the development of new ventures,
- Increase the awareness of all University and community stakeholders of the importance of intellectual property identification and protection and technology transfer and commercialization,
- Increase the regional and national visibility and success of University of South Florida (USF) and Tampa Bay area technologies and corporate spin-outs.

Students/Stakeholders Served by the *Technology Entrepreneurship* **Pedagogy:**

The *Technology Entrepreneurship* pedagogy is designed for graduate students (Master's and Doctoral) in the disciplines of science, medicine, engineering, business, and law. In addition, faculty members and community business leaders and entrepreneurs have made use of the pedagogy to increase their knowledge and background in the fields of business and entrepreneurship, to identify intellectual property and technologies for development and commercialization, and to identify the highest quality students as potential employees, associates, and partners. Further, the University is served by the evaluation of the research, intellectual property portfolios, and technologies to identify and accelerate the appropriate technology transfer candidates and commercialization and new venture strategies. The Tampa Bay business community also benefits as a result of the process of technology commercialization as strategic partners and service providers. Local and regional technology clusters gain through the availability of better licensing opportunities for commercialization and the development of viable new ventures. Finally, society benefits from the availability of the technologies to provide the means of improving the quality of life.

Description of *Technology Entrepreneurship* **Pedagogy:**

At USF, we have striven to develop a *program-wide* pedagogy with strong, consistent *learning threads* throughout the curriculum; focused on inter-disciplinary cooperation between students, faculty, colleges, University, and community organizations with case-based discussions of specific and pertinent topics, and team-based projects *that result in technology commercialization and/or new venture formation and long-term success for the newly-founded companies, the University, and the community that developed the research and technologies which are the basis for the companies.* The pedagogy has been developed for graduate students from the disciplines of science, medicine, engineering, law, and business. Inter-disciplinary project-based teams of students under the direction of an inter-disciplinary faculty from the Colleges of Business Administration, Engineering, and Health Sciences and The Center for Entrepreneurship with strong professional experience as academicians, practitioners, and entrepreneurs.

The pedagogy is based on *constructivist-learning theory using a collaborative learning mechanism* within the inter-disciplinary, project-based student teams. Constructivist learning theory assumes that learners develop knowledge based on a process of organization and understanding of their experiences. These experiences create schemas, or mental models, which are altered, enlarged, and made more sophisticated through the processes of assimilation and accommodation. New information causes perturbations in these organization structures and processes which require reflection on, and reassessment of, previous experiences and developed knowledge with resultant formation of new knowledge to account for the new information. Teacher-instructors assist students and teams through these processes to aid in the development of insight and knowledge.

This type of learning is an active, team-based process where the teams and team members construct knowledge based on what they know and the relationship of new information presented by the instructor, obtained or developed by the team, or by the individual team members within the interactions of the class or the individual teams. It is generally found that the knowledge developed and generated by the inter-disciplinary team concept is much broader and deeper than could be formulated by any one individual or team of individuals with similar background. This pedagogy requires a student-centered learning environment which encourages students to ask questions, allows students to make their own analogies, draw their own conclusions, and use individualized active processes for developing insight and building knowledge. Within this framework, the teacher-instructor's role is to scaffold information into conceptual clusters of problems, questions and conflicting situations from which the students can be challenged and can challenge their individual and team knowledge bases so as to re-define, re-construct, and expand these knowledge bases based on new experiences and information. Instruction within this pedagogy is:
- developed to provide a consistent base of information to all student-learners within the context of the instructional material
- concerned with the experiences, convictions and constructs that student-learners already possess
- structured to be understood and modified by student-learner teams
- designed to facilitate exploration, extrapolation, and elaboration by student-learners and learner teams

Collaborative learning (CL) is based on the concept of small teams of students assisting each other in the learning process. Five (5) critical elements have been identified in true CL:
1) Positive interdependence—strong, continuing linkages between the students leading to success for all team members together;
2) Promotive interaction—the gathering and sharing of knowledge and learning between the team members;

3) Individuality accountability—accountability by each team member for three processes: 1) active engagement in the group activity, 2) completing a fair share of the team's work, 3) assisting other team members in learning achievement and demonstration of competence;

4) Development of social (teamwork) skills—learning of skills in leadership, decision making, trust building, communication, and conflict management;

5) Group self-evaluation—continual and on-going evaluation of the team processes and modification as required.

CL has been shown to result in higher grade achievement and student engagement, especially when the students are heterogeneous in terms of background, experience, expertise, and achievement—a *sine qua non* of inter-disciplinary teams. CL has been shown to achieve better critical thinking skills and a higher level of learning and critical thinking—due to the group analysis, critique, debate, and shared analysis—and assists in the development of problem-solving strategies and skills due to the group interaction and communication required; all critical to inter-disciplinary teams.

By using real and live projects within a case-based, collaborative learning, inter-disciplinary team environment under the direction of instructors with strong academic credentials and experience in conjunction with experience in the "real-world" as practitioners and entrepreneurs, the pedagogy is designed to provide the students an opportunity for "situated learning" to identify and become a part of a "community of practice". (Fig. 1) A key aspect is the notion of the *apprentice observing the "community of practice"*. It has been demonstrated that the initial participation in a culture of practice can be observation from the periphery or "legitimate peripheral participation". The participant moves from the role of observer, as learning and observation in the culture increase, to a fully functioning member. The progressive movement towards full participation enables the learner to piece together the culture of the group and establish their identity. This theoretical construct, the "Zone of Proximal Development", states that learning occurs best when an expert guides a novice from the novice's current level of knowledge to the expert's level of knowledge. Bridging the "zone of proximal development" construct with the legitimate peripheral participation construct may be accomplished if one thinks of a zone in which the expert or mentor takes the learner from the peripheral status of knowledge to a deeper status. This pedagogy is designed to allow the instructor to function in the role of expert/mentor and to help transition the student-learner from the peripheral status to the deeper position.

It is the philosophy at USF that Technology Entrepreneurship is a professional's/practitioner's art—based on broad curriculum content to develop intellectual breadth, domain depth, and application expertise and experience. Because of this, we feel that individualized instruction, mentorship, and graduated levels of increasing monitored responsibility of students, interns, residents, and fellows (which can all be included in the term "apprentices") under the direction of experienced practitioners are crucial to this pedagogy. This "apprenticeship model" involves peers (novices) working closely together with a teacher (expert) in joint problem solving. We have drawn heavily from the medical education model, which has a long history of education and training using these techniques. Medical education, even from its earliest stages in antiquity, was an apprenticeship with students learning from practitioners, albeit not always expert practitioners. After the publication of the Flexner report in 1910, medical education in the United States was re-organized to require a fundamental background in the basic sciences and formalized training with, and under the direction of, demonstrated and acknowledged experts. Medical graduates worked under the guidance of an expert clinician to learn the practice of medicine/surgery—a body of knowledge steeped in technical procedures and processes and in "know-how". Upon review, and when analyzed using current tools and terminology, this was very much a project-based (the patient), collaborative, constructionist and experiential-learning process. The knowledge base and fund of knowledge is constantly enlarged and revised based upon on-going study, research, practice, and experience; and modified and refined with the guidance and mentorship provided on the scaffolding of the more extensive knowledge, expertise, and experience of the instructing clinician/surgeon. Further, the student/apprentice must develop an ability to function within, and to ultimately manage and lead, inter-disciplinary teams. This construct is easily translated to an Entrepreneurial Business Education model. The practice of Entrepreneurship, especially serial entrepreneurship, is a collaborative, constructivist, experiential process; best learned under the teaching and guidance of an expert, experienced entrepreneur/mentor. The student/apprentice must have broad and deep knowledge in a variety of subjects, including accounting, finance, marketing, management, and statistics. The projects, especially in Technology Entrepreneurship, require inter-disciplinary teams and the successful entrepreneur must be able to function in, manage, and lead these teams.

We have utilized this pedagogical model using a variety of instructional strategies:
- Direct Instruction—didactic instruction from instructor to students to build an infrastructure of knowledge,
- Indirect Instruction—usually case-based; where knowledge is developed through individual reflection, study, and team interactions,

- Experiential Learning—where knowledge is developed through "hands-on" activities that expand the student's experiences and result in the development of new knowledge,
- Independent Study—study that is focused through appropriate mentoring and coaching, but completed individually or within a team to expand and consolidate the student's knowledge,
- Interactive Instruction—can combine all of the above strategies within the construct of computer-based resources

The close interaction with the faculty allows the development of *inter-subjectivity*; the sharing of focus and purpose between the novice, expert, and peers. Within this situated context, the novice is able to participate in skills beyond those that they are capable of handling independently. The internalization of the shared cognitive process by the novice extends existing knowledge and skills. The process for this internalization takes place through the following methods:

- Modeling—involves an expert carrying out a task so that student can observe and build a conceptual model of the processes that are required to accomplish the task,
- Coaching—consists of observing students carrying out a task and offering hints, feedback, modeling, reminders, etc.,
- Articulation—includes any method of getting students to articulate their knowledge, reasoning, or problem-solving processes,
- Reflection—enables students to compare their own problem-solving processes with those of an expert or another student,
- Exploration—involves pushing students into a mode of problem solving on their own. Forcing them to do exploration is critical if they are to learn how to frame questions or problems that are interesting and that they can solve.

Unique Aspects of the *Technology Entrepreneurship* **Pedagogy:**

The unique aspects of this pedagogy include:

- *Development* of strong, consistent *learning threads* throughout and across an entire program curriculum
- an *Inter-disciplinary Student Body* (Business, Engineering, Science/Medicine, Legal)
- an *Inter-disciplinary Faculty* (with professional experience as academicians, practitioners, and entrepreneurs)
- Development and institution of a *USF Graduate Certificate in Technology Entrepreneurship*
- Development and institution of a *USF Masters of Science Degree in Entrepreneurship in Applied Technologies*
- *University and Community Investigator/Entrepreneur Support and direct interaction with student teams*
- *University and Community Support* (at University, College, and Department levels and Community Business and Political leaders and mentors)
  - *Inclusion of USF Division of Patents and Licensing as active stakeholders working with student teams*
  - *Inclusion of Kauffman Entrepreneur Intern and Tampa Bay CEOs Council Internship Programs*
- *Inclusion and Integration of local business community mentors* for provision of professional services and resources to student teams and University investigators

Sources of Support for the *Technology Entrepreneurship* **Pedagogy:**

The *Technology Entrepreneurship* pedagogy is supported by the USF Colleges of Business Administration, (COBA), Engineering (COE), and Health Sciences (COHS) financially and with faculty and administrative support; by the Tampa Bay community financially and with projects, opportunities, and mentorship, and by the Kauffman Foundation. We have found the commitment at a University senior administrative level, i.e., a champion as director of the entrepreneurship program, and champions within the University and each participating college, and within the local community to be an absolute requirement for success. There is also significant support provided, in the form of intellectual property portfolios, research, and technologies and products for evaluation by the Colleges of Marine Sciences and Arts and Sciences, the USF Research Foundation, the USF Division of Patents and Licensing, the H. Lee Moffitt Cancer Center and Research Institute, and the Tampa Bay community. The Tampa Bay business community has provided substantial support financially and through mentoring and the provision of significant business resources and services; and the Kauffman Foundation has been a strong financial supporter through multiple grants.

Student/Stakeholder Benefits from the *Technology Entrepreneurship* **Pedagogy:**

Many benefits have accrued to the students from the *Technology Entrepreneurship* pedagogy. One unique advantage is the use of the same pedagogy and learning threads throughout an entire curriculum of study which provides consistency for the students and faculty. Further, the students experience an in-depth interaction within the inter-disciplinary team environment. Most students, prior to exposure to this pedagogy, have been "silo'ed" within their field of study and expertise, and there are often significant predispositions and biases (usually negative) regarding the abilities and capabilities of individuals with different areas of expertise and experience. These inter-disciplinary projects require varied talents and skills, and the students gain an appreciation of individuals with skills and knowledge that they may not have. This pedagogy is an excellent gauge of the students' ability to function appropriately within the type of inter-disciplinary teams that will likely be experienced in real-world employment situations. Students also develop experience in areas not usually part of typical science, engineering, or business curricula; specifically, intellectual property, regulatory approval, and compliance. Most students are required to develop and refine critical skill sets, using a wide variety of tools and resources that will be useful in many different employment situations, especially those that are technology-related. Students also benefit from significant individualized attention from a broad-based faculty with significant experience in academia, entrepreneurship, a variety of scientific and technical fields, and business. Finally, this *Technology Entrepreneurship* pedagogy and curriculum assists the students in developing a "life skills" educational program which can be utilized within a life-long learning framework to assess problems and issues and develop appropriate solutions in any professional career.

The faculty and community investigators, and the faculty and community in general, have become much more aware of the challenges and benefits of technology commercialization and new venture formation. In addition, the University and community have benefited from the evaluations of the intellectual property portfolios and technologies for potential commercialization. The Tampa Bay business community has also benefited as a result of the process of technology commercialization as strategic partners and service providers.

Outcomes of the *Technology Entrepreneurship* **Pedagogy:**

This pedagogy has directly involved 750 graduate students over an eight year period (1998-2005) in 65 individual courses. Specific demographic details for the four major courses are shown in Tables 1-4 below.

As noted by the Association of University Technology Managers (AUTM) in 2002, USF was ranked in the top 10 nationally for the creation of start-up companies, an acknowledgement that unquestionably increases the recognition of USF and its spin-out firms—firms that almost without exception have been evaluated through the multiple classes of the *Technology Entrepreneurship* pedagogy.

In 2001, the *Strategic Market Assessment for New Technologies* course was selected as a national benchmark model in inter-disciplinary Life Sciences education by the National Consortium for Life Sciences Entrepreneurship, in conjunction with the Kauffman Foundation. It has since been adopted and adapted for use in other major U.S. universities. In 2004, the USF Life Sciences Entrepreneurship Program was selected as the Outstanding Specialty Entrepreneurship Program by USASBE, and in 2005 the *Strategic Market Assessment for New Technologies* course was selected as the Outstanding Innovative Entrepreneurship Education Course by USASBE. Finally, the pedagogy and curriculum have been critically reviewed and accepted by the University and the State of Florida such that a Graduate Certificate in Entrepreneurship was approved in January 2005 and ***an innovative and unique Master's of Science Degree in Entrepreneurship in Applied Technologies was approved and launched in the Fall 2005 with 10 students.***

CONCLUSIONS AND RECOMMENDATIONS

The development and implementation of *Technology Entrepreneurship Pedagogy* at the University of South Florida has resulted in unique and innovative inter-disciplinary learning opportunities through an entire curriculum for graduate students in multiple disciplines, increased interaction among the faculty and Colleges, and significant benefits for the University and the Tampa Bay community. This has also enhanced the awareness of technology commercialization in University faculty and administration and the Tampa Bay community, and has resulted in an increased rate of successful commercialization of USF faculty technologies and innovations and development of successful spin-out ventures. This pedagogy is an appropriate model for use in other educational institutions; for academic purposes, evaluation of institutional research, technology transfer commercialization, and economic development.

References

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2. Marshall WG, Jr., Budd S, Givens P, Fountain MW: "Entrepreneurial Assessment of Technology Commercialization and New Venture Formation Using a Decision Matrix to Direct Commercialization Strategies", (presented at USASBE 2005)

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7. Herrington, J. and Oliver, R. (1995), "Critical characteristics of situated learning: Implications for the instructional design of multimedia", presented at the Australian Society for Computers in Learning in Tertiary Education Conference.
http://www.ascilite.org.au/conferences/melbourne95/smtu/papers/herrington.pdf

Figure 1.

Mutually Constructive Elements of New Learning Pedagogy [modified from Herrington J and Oliver R]
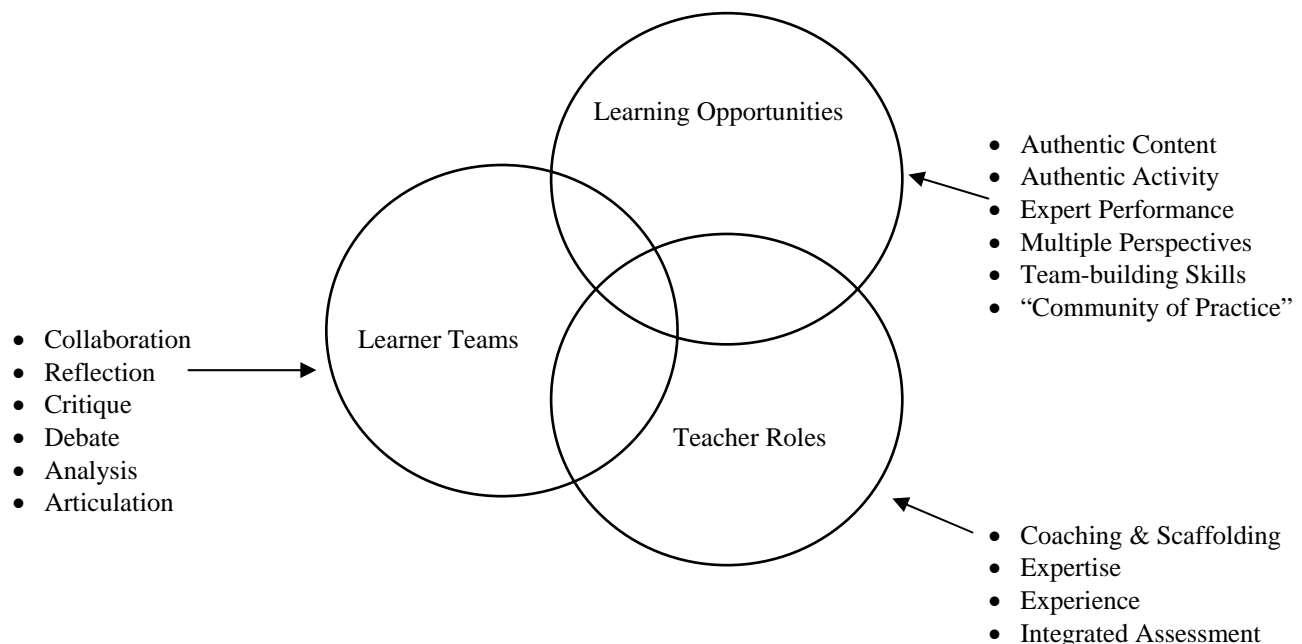
Table 1.

USF ENTREPRENEURSHIP PROGRAM DEMOGRAPHICS

CLASS: STRATEGIC MARKET ASSESSMENT for NEW TECHNOLOGIES

Year	Students	Males	Females	Minority Students			
1997-98	0	0	0	0			
1998-99	0	0	0	0			
1999-2000	9	4	5	3			
2000-01	21	12	9	4			
2001-02	29	20	9	5			
2002-03	22	17	5	3			
2003-04	18	9	9	10			
2004-05	33	16	17	9			
Total	132	78	54	34			

USF ENTREPRENEURSHIP PROGRAM EDUCATIONAL DEMOGRAPHICS

CLASS: STRATEGIC MARKET ASSESSMENT for NEW TECHNOLOGIES

Year	COBA	COE	COM	College-Other	Grad. Program	U/G Degree	Grad. Degree	
1997-98	0	0	0	0	0			
1998-99	0	0	0	0	0			
1999-2000	9	0	0	0	9 MBA	1 BA		
2000-01	16	0	4	1	16 MBA, 4 PHD-MED, 1 other	4 BS, 7 BA		
2001-02	29	0	0	0	29 MBA	5 BS, 2 BA		
2002-03	22	0	0	0	19 MBA, 1MDX, 2 Master TRS			
2003-04	9	7	0	2	9 MBA, 1 MS-EGG, 1 MS-EEL, 3 PHD/Doctorate-EEL, 2MS-EMA, 2 other			
2004-05	28	5	0	0	24 MBA, 4 Master-TRS, 3 MS-EEL, 1 MS-EBI, 1 MS-EMA			
Total	113	12	4	3				

Table 2.

USF ENTREPRENEURSHIP PROGRAM DEMOGRAPHICS

CLASS: <u>BUSINESS PLAN DEVELOPMENT</u>

Year	Students	Males	Females	Minority Students			
1997-98	0	0	0	0			
1998-99	0	0	0	0			
1999-2000	0	0	0	0			
2000-01	35	18	17	5			
2001-02	36	27	9	9			
2002-03	37	23	14	6			
2003-04	28	20	8	10			
2004-05	34	21	13	2			
Total	**170**	**109**	**61**	**32**			

USF ENTREPRENEURSHIP PROGRAM EDUCATIONAL DEMOGRAPHICS

CLASS: <u>BUSINESS PLAN DEVELOPMENT</u>

Year	COBA	COE	COM	College-Other	Grad. Program	U/G Degree	Grad. Degree	
1997-98	0	0	0	0	0			
1998-99	0	0	0	0	0			
1999-2000	0	0	0	0	0			
2000-01	31	0	4	0	31 MBA, 4 PHD-MED	9 BS, 10 BA		
2001-02	35	1	0	0	34 MBA, 2 unknown	7 BS, 3BA		
2002-03	37	0	0	0	35 MBA, 1 MDX, 1 Masters-TRS	14 BS, 3 BA		
2003-04	26	2	0	0	26 MBA, 1 MS-EEL, 1 PHD-EEL	5 BS, 5 BA		
2004-05	31	3	0	0	27 MBA, 4 Masters-TRS, 1 MS-EEL, 1 MS-EBI, 1 unknown	1 BS, 1 BA		
Total	**160**	**6**	**4**	**0**				

Table 3.

USF ENTREPRENEURSHIP PROGRAM DEMOGRAPHICS

CLASS: <u>NEW VENTURE FORMATION</u>

Year	Students	Males	Females	Minority Students			
1997-98	0	0	0	0			
1998-99	0	0	0	0			
1999-2000	0	0	0	0			
2000-01	35	19	16	5			
2001-02	35	26	9	9			
2002-03	37	23	14	6			
2003-04	28	18	10	7			
2004-05	34	20	14	10			
Total	169	106	63	37			

USF ENTREPRENEURSHIP PROGRAM EDUCATIONAL DEMOGRAPHICS

CLASS: <u>NEW VENTURE FORMATION</u>

Year	COBA	COE	COM	College-Other	Grad. Program	U/G Degree	Grad. Degree	
1997-98	0	0	0	0	0			
1998-99	0	0	0	0	0			
1999-2000	0	0	0	0	0			
2000-01	31	0	4	0	31 MBA, 4 PHD-MED	9 BS, 10 BA		
2001-02	35	0	0	0	35 MBA	7 BS, 3 BA		
2002-03	37	0	0	0	35 MBA, 1MDX, 1 Masters-TRS,	14 BS, 3 BA		
2003-04	26	2	0	0	26 MBA, 1 MS-EEL, 1 PHD EEL	5 BS, 5 BA		
2004-05	31	3	0	0	27 MBA, 4 Masters-TRS, 1 MS-EEL, 1 MS-EBI, 1 unknown	6 BS, 7 BA		
Total	160	5	4	0				

Table 4.

USF ENTREPRENEURSHIP PROGRAM DEMOGRAPHICS

CLASS: ADVANCED TOPICS in ENTREPRENEURSHIP

Year	Students	Males	Females	Minority Students			
1997-98	0	0	0	0			
1998-99	15	10	5	3			
1999-2000	17	9	8	8			
2000-01	16	9	7	2			
2001-02	20	10	10	3			
2002-03	8	6	2	1			
2003-04	9	5	4	5			
2004-05	9	8	1	6			
Total	94	57	37	28			

USF ENTREPRENEURSHIP PROGRAM EDUCATIONAL DEMOGRAPHICS

CLASS: ADVANCED TOPICS in ENTREPRENEURSHIP

Year	COBA	COE	COM	College-Other	Grad. Program	U/G Degree	Grad. Degree	
1997-98	0	0	0	0	0			
1998-99	14	1	0	0	14 MBA, 1 MS-EMA	6 BS, 3 BA		
1999-2000	15	2	0	0	15 MBA, 1 MS-ECH	2 BS, 4 BA		
2000-01	16	0	0	0	16 MBA	2 BS, 5 BA		
2001-02	20	0	0	0	20 MBA	4 BS, 1 BA		
2002-03	8	0	0	0	7 MBA, 1 MDX	1 BS		
2003-04	6	3	0	0	6 MBA, 1 MS-EIE, 1 MS-ECN, 1 MS-EEL	3 BS, 1 BA		
2004-05	6	3	0	0	6 MBA, 2 MS-EEL, 1 MS-EBI	2 BS, 1 BA		
Total	85	9	0	0				