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Collaborative Course Design of Entrepreneurship Projects in a College of Computer Science and Information Systems

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Abstract

Colleges are engaging students in collaborative design courses on diverse projects. More of the courses could be focusing on cross-disciplinary entrepreneurship projects including computer science and information systems students with other disciplinary students. The authors of this paper describe a course that is focusing on collaborative design and cross-disciplinary entrepreneurship on innovation projects by students as members of self-directed teams. The course is involving the students on crowdfunding projects of product prototyping, from which they are learning a marketable repertoire of skills. The findings of this paper will be beneficial to educators in colleges of computer science and information systems considering enriching pedagogical practices to be contemporary with the demands of industry.

Keywords: collaborative learning, cooperative learning, design factory, entrepreneurship, experiential learning, information systems curriculum, self-directed teams, problem-based learning, project-based learning

1. BACKGROUND

Active collaborative learning is an alternative concept of directly engaging students in the content of courses, instead of having students listening to lectures (Felder & Brent, 2016a). Engagement consists of divergent exercises for fostering deep learning of the material of the courses (Wang, Su, Cheung, Wong & Kwong, 2014). Engagement in colleges of computer science and information systems could consist especially of active interactions for cooperative learning (Johnson, Johnson & Smith, 2016) with other cross-disciplinary students. Knowledge from courses is consistently enhanced in group learning practices on projects indicated in the literature (Prince, 2004). Active collaborative learning is clearly an approach for increased learning of students.

Concurrently, courses in entrepreneurship are developing as an area of curricula for applying collaborative group learning. Entrepreneurship is already an example of collaborative design experiential learning practices (Noyes, 2018), in including students on projects. Entrepreneurship in colleges of information systems could involve students actively on high-potential projects as members of passionate teams (Byers, Dorf & Nelson, 2011). Focus of learning is not from lectures but from forms of problem-based learning (Barrett & Moore, 2011) and project-based learning (Prince & Felder, 2007) of the students on teams. Collaborative learning and entrepreneurship are approaches equivalently for further increased learning of students.

Not enough colleges of computer science and information systems are however including diverse approaches of learning such as active collaborative learning in courses such as entrepreneurship (Schrage, 2018). Lectures are indicated to be frequent knowledge methods inappropriate for the learning of marketable skills (Stains, Harshman, Barker, Chasteen, Cole, DeChenne-Peters & Young, 2018). Marketability of students is formed more from collaborative problem-based learning and project-based learning practices that are inherently industry practices. Marketability is found further from performances of these practices as skills on spirited student teams (Magana, Seah & Thomas, 2018). Therefore, this paper introduces a course, beyond basic current entrepreneurship syllabi, for engaging students in active collaborative design learning on entrepreneurship projects in a school of computer science and information systems.

2. INTRODUCTION

The course in this paper is *Collaborative Design Innovation*, begun in winter / spring 2019 in the Seidenberg School of Computer Science and Information Systems of Pace University. The course is an active learning experience for students in cooperatively exploring entrepreneurial products as members of project self-directed teams (Sears & Pai, 2012). The dimensions of the experiences are formed from cooperative learning (Connolly & Rush, 2018) and experiential learning (Noyes, 2018) and problem-based and project-based learning, as depicted in Figure 1 of the Appendix. The experiences are formulated further from a "design factory" experimental learning platform for interdisciplinary inventions (Ekman, 2018). The instructor, the second author of this paper, functions as a facilitator, not as a lecturer, to the students (Guthrie, 2010). The students function as the intended participants on the projects of their teams.

The learning objectives of the 3-credit course of 14 3-hour sessions are below:

- Experience challenges of collaborative dynamics in designs of big idea entrepreneurship projects, as members of self-directed teams;

- Experience design methods on ideation processes of product storyboarding and product prototyping projects, as students and as student teams;

- Experience and learn improved marketable skills, including collaboration, communication, creative thinking, critical thinking, diversity, empathy, entrepreneurship, flexibility, management and problem solving, from interactions with cross-disciplinary students on the projects;

- Experience new industry opportunities and perspectives on the entrepreneurship projects and the potential solutions, as students and as student teams; and

- Experience crowdfunding entrepreneurship pitch presentations of functional product prototyping solutions, as students and as student teams.

The course is a diverse experience inclusive of computer science and information systems students and interdisciplinary liberal arts and business students, for increased learning of the computer science and information systems students of other perspectives of students not in the Seidenberg School.

The learning plan of the course is conceptualized below for the 14 semester sessions:

Orientation

(Weeks 1 -2)

- Challenges and Fears
- Collaborative Culture for Design Entrepreneurial Mind and Process
- Expectations and Experiences on Design Projects and Factors for Innovation Projects
- Design Factory Methodology
- Potential of Interdisciplinary Teams on Innovation Projects

Organization

(Weeks 3-4)

- Expectations of Industry on Big Idea Projects
- Funding Perspectives on Big Idea ("Blue Sky") Projects
- Gathering Perspectives on Big Idea (Products) Projects
- Gathering and Learning (Products) Requirements

- Parameters of Projects (from Professor)

Process

(Weeks 5 -12)

- Brainstorming (Brainwalking) on Big Idea (Products) Projects
- Storyboarding Big Idea (Products) Projects Scenarios
- Prototyping Big Idea (Products) Projects Simulations
- Prototyping Big Idea (Products) Projects (Features) Specifications
- Prototyping Big Idea (Products) Projects Prototypes in Stages

- Product Development Process
- Rapid Application Development (RAD) and Iteration Steps

- Pitch Presentation Standards (from Professor)

Production

(Weeks 13 -14)

- Final Big Idea (Product) Projects Prototypes
- Gala Pitch Presentations of Big Idea (Products) Projects Prototypes

The syllabus of *Collaborative Design Innovation* is detailed further, with deliverables, exercises and films, and sub-topics and treks of the weeks, in Table 1 of the Appendix, with customization feasible to other information systems and business syllabi.

The course in winter / spring 2019 consisted of n=5 distinct entrepreneurship organizations or projects, decided by members of n=5 incubating self-directed teams of mostly n=5 members a team, in a class of n=27 in total. The instructor decided deliberatively on the members of the teams, in order to ensure diversity as feasible by demographics, discipline, gender and student year on the teams (Weimer, 2018), but members had the option to transfer to one other team by the end of the second class session, though none transferred. The characteristics of the students by demographics are below:

- 3 African-Americans
- 15 American Caucasians
- 5 Asian-Americans
- 1 European International
- 3 Hispanic-Americans

The disciplines of the students are below:

- 14 Seidenberg School of Computer Science and Information Systems
- 7 Liberal Arts, Health and Humanities*
- 6 Lubin School of Business

*multiple schools of Pace University

The genders of the students are as follows:

- 7 Female
- 20 Male

The student years are as follows:

- 12 Freshman
- 7 Sophomore
- 4 Junior
- 4 Senior

From instructor parameters of a rapid application development process (RAD), the members of the teams explored authentic consensus learning projects (Bell, 2010). The projects involved a collaborative design innovation laboratory, a dance entertainment exchange system, a disposable i-phone charger system, an e-cigarette filtration system, and a firearm detection school system zone, for hypothetical organizations, though the students postured as owners. From the projects, they initiated their own learning in the semester (Helle, Tynjala, Olkinvora & Lonka, 2007). They functioned as 1 group in classroom sessions and as 5 teams in "creative spaces" (Baidawi, 2018) of the Seidenberg School. The implementation of the projects in prototyping solutions was the responsibility of the teams.

The instructor helped the members of the teams in learning the design factory learning platform (Ekman, 2018). Importantly, the instructor helped as a mentor the student teams in the classroom sessions, in the School spaces, and on the Discussion Board of the Academic Blackboard e-Education Suite. He included materials (e.g., flipcharts, markers and post-its) if needed by the student teams.

From luncheons, mini-presentations of the teams, and notably reflection reports and research studies of those on the teams – "hooks" (Reynolds & Kearns, 2017), as in Table 1, the professor monitored the progress of the projects of the teams without intruding on the responsibilities of the teams. He motivated them with exercises and games, external labs and movies and "Escape the Room" (Groupon), "Let's Talk Relieving Stress" and "WeWork" Workspace treks in the semester. Moreover, he motivated them with interactions with entrepreneurship mentor firms and equity investor firms as alternate available face-to-face sources (Magana, Seah & Thomas, 2018), also as in Table 1.

At the end of the 14th session, the product prototyping solutions were presented as pitch presentations or final reports (Thompson & Beak, 2007) as if to venture capitalists. The instructor graded 50% for member performance and 50% for performance as a team. As an option, students graded themselves as input to the instructor.

Finally, for books of *Collaborative Design Innovation*, the instructor included Kelley & Kelley, Creative Confidence: Unleashing the Creative Potential Within Us All and Bjorklund, T.A., et.al., Passion-Based Co-Creation, both for the reference; and for publications, Entrepreneur for practitioner study and the Journal of Innovation and Entrepreneurship and the Journal of Social Entrepreneurship for scholarly study.

3. FOCUS OF PAPER

The benefits of the course as an authentic learning experience are the focus of this paper.

Courses in designing entrepreneurship projects as if the projects are done in industry are considered excellent for executive function skills (DiTullio, 2018). Courses consisting of project-based learning on entrepreneurship are considered as encouraging improved marketable skills of students (Gol & Nafalski, 2007). Firms in industry desire information systems students to function in organizations as problem solvers (Schwering, 2015) by having as team players a heterogeneity of skills beyond skills in technology (Ambrosio, 2018), a justification for the *Collaborative Design Innovation* syllabus. Factors of learning outcomes are focused on perceptions of a repertoire of skills found from the literature (Bjorklund, et.al., 2017, Gedeon & Valliere, 2018 & Felder & Brent, 2016b) and are integrated for this paper:

- Collaboration (Bjorklund, et.al., 2017) – factor from which students perceived improved fruitful engagement skills with other students;

- Communication (Gedeon & Valliere, 2018) – factor from which the students perceived increased interaction and listening skills with other students;

- Creative Thinking (Felder & Brent, 2016b) – factor from which students perceived increased experimental and imaginative ideation skills with other students on their teams;

- Critical Thinking (Felder & Brent, 2016b & Gedeon & Valliere, 2018) – factor from which the students perceived increased interpretative logical skills with other students;

- Diversity (Bjorklund, et.al,, 2017 & Felder & Brent, 2016b) – factor from which students perceived increased cross-cultural interdisciplinary skills with other peer students;

- Empathy (Bjorklund, et.al., 2017) – factor from which the students perceived increased inter-personal sensitivity skills with other peer students on their teams;

- Entrepreneurship (Bjorklund, et.al., 2017 & Gedeon & Valliere, 2018) – factor from which students perceived increased improvised innovation skills with other students and persuasion skills on their teams;

- Flexibility (Gedeon & Valliere, 2018) – factor from which the students perceived increased group negotiation and perspective skills, notably in stressful situations with other students;

- Management (Gedeon & Valliere, 2018) – factor from which students perceived increased organizational and personal planning skills, such as time management, with other students on their teams; and

- Problem Solving (Bjorklund, et.al., 2017 & Felder & Brent, 2016b) – factor from which the students perceived increased optimal resolution skills with other students on their teams.

The benefits of *Collaborative Design Innovation* in addressing an alternative to non-collaborative learning in winter / spring 2019 may be from evaluation of the above factors, which will be beneficial to instructors considering enriching pedagogical practices to be current with the goals of industry.

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v5 n4907

4. METHODOLOGY OF PAPER

The methodology of this paper evaluated the perceptions of the students in the *Collaborative Design Innovation* course in the Seidenberg School of Computer Science and Information Systems of Pace University.

The perceptions pf the n=27 undergraduate students were evaluated from the aforementioned n=10 factors of skills, defined by the instructor for the students. Following the pitch presentations at the end of the semester in spring 2019, the students furnished their perceptions of progression anonymously and quantitatively on a pre-tested Likert-like instrument, rating their learned or non-learned skills, from the aforementioned definitions of the skills, from a very high (5) impact to a very low (1) impact or zero (0) scaling on their skills. Moreover, the students furnished perceptions of their progression non-quantitatively and separately in their mid-term and final reflection reports of the semester.

The interpretation of the statistics was fulfilled from Microsoft EXCEL 2016 16.0 and IBM Statistics 24 (Adams & Lawrence, 2019), for the findings in the next section of this study.

5. ANALYSIS AND DISCUSSION OF FINDINGS

The analysis of the evaluations is disclosing favorable impacts (means=4.17 /5.00) from the overall perceptions of the n=27 students. Evaluations of the n=27 students are highlighting favorable ratings from collaboration (4.33) to problem solving (4.48) skills. Evaluations of the perceptions of the n=14 computer science and information systems students of the learning process are especially highlighting favorable ratings from collaboration (4.14), communication (3.86), creative thinking (4.50), critical thinking (4.36), diversity (4.71), empathy (3.36), entrepreneurship (4.29), flexibility (3.93), management (4.07) and problem solving (4.43). Such evaluations are from interactions on the projects of the n=5 small groups as an apparent ideal number on small teams (Bean, 2011) involving the novelty of liberal arts and business students on the teams (Matsudaira, 2018). As to the n=13 liberal arts and business students, evaluations are indicating favorable learning ratings from collaboration (4.67 and 4.50) to problem solving (4.43 and 4.67) skills. Evaluations of these perceptions of the students are descriptively documented in Tables 2A (all students) and 2B (computer science and information systems, business and liberal arts students) of the Appendix.

Evaluations of freshmen (4.27), sophomore (3.93), junior (3.93) and senior (4.50) students individually are indicating overall favorable ratings.

Evaluations of the students by years are documented in Tables 3A (freshmen students) and 3B (sophomore, junior and senior students).

Findings are further highlighting favorable ratings behind these perceptions from collaboration (4.18) to problem solving (4.45) design skills from computer science and information systems students that were not in previous semesters on small teams. Previously such students were on individualized projects without interactions with other non-computer science and non-information systems students. Other findings from collaboration (4.71) to problem solving (4.57) factors from overall liberal arts and business students not previously on self-directed small teams are highlighting an equivalent favorable snapshot, and such students will be experienced now and favorably if not hopefully inclined to be on projects on small teams in future semesters.

The benefits of active authentic learning are evident from the findings. Collaboration (4.33) and communication (4.04) of all students in Table 2A are effectively facilitating big idea breakthroughs in the brainstorming to the prototyping and of the students, as they are first focusing on gaining insights on the problems of the projects, not the answers but the questions (Gregersen, 2018). In fact, contracts developed by each of the students for outcomes of the projects are identifying their responsibilities on their teams (Landfair, 2018), improving communication and collaboration of the students.

Though discomforting at first, diversity (4.33) and empathy (3.22) of all students in Table 2A are indicating contributing factors in emotional intelligence (Salovey & Mayer, 1990), in the formation of the projects and in the results by empathizing demographic, gender and, importantly, interdisciplinary students, as members of their teams (Tappert, Leider & Li, 2019), which as an example in the humanities of liberal arts included dance studio students not known normally to information systems students.

Entrepreneurship (4.56) of all students in Table 2A is also indicating freedom in ingenuity in inventive opportunities in the solutions of these students.

Factors of flexibility (3.93) and management (4.00) are impacts in the learning of organizational and perceptual skills, notably as the projects stressed the students. Increased learning of creative thinking (4.52) to learning of critical skeptical thinking (4.33) of all students in Table 2A as members of teams (Bean, 2011) is indicating informed ingredients in the project solutions of the students. Participant problem solving (4.48) in pursuing the prototyping solutions and visualizations (Roam, 2008) as members of teams, not as " lonely riders", is indicating in Table 2A the importance of the learning and of sharing for all of the students (Park & Choi, 2014). These findings from the cooperative process of problem-based and project-based learning are indicating the gradual learning of an optimal repertoire of skills (Bell, 2010) by all of the n=27 students and notably by the n=14 computer science and information systems students, a justification for *Collaborative Design Innovation* to be offered in multiple semesters.

Finally, findings of correlations and frequency distributions of the perception ratings of the students are documented in Table 4 and Table 5.

6. IMPLICATIONS FOR PRACTICE

The findings found in this paper are highlighting the benefits of a collaborative design course for computer science and information systems students. These students are dialogically interconnecting with liberal arts and business students, with whom without the course they might not be interacting to do the projects (Barnes, 2019). They are cooperatively learning and are open and patient to other demographic and gender perspectives of the business and the liberal arts students not similar to theirs, in order to produce project results. The problem-based and project-based learning is driving the solutions of the students (McKay, 2018). The implication for computer science and information systems instructors is that for appropriate courses, and as feasible, students will benefit from a course designed for involving non-computer science and non-information systems students.

The findings are further highlighting the benefits of disruptive and non-disruptive interdisciplinary projects for computer science and information systems students. They are identifying innovation opportunities for project solutions and visualizations (Roam, 2008) from a learning process of brainstorming, storyboarding and prototyping that is akin to industry practices (Kim & Mauborgne, 2019). The implication for computer science and information systems instructors is that their students will benefit from a course designed for inclusion of industry innovation practices on projects.

The computer science and information systems students in the course are indicating that they are learning in-demand skills. The gap in industry skills is not necessarily in hard skills but in persuasive "soft skills" (Davis, 2018) such as from the collaboration to problem solving skills they are learning on the projects. The gap is generally notable on other project teams in the Seidenberg School, but in the course the students are helping other students (Tamer, 2018), learning the soft skills to be team players and recognizing the skills in other students. Schools of information systems are not often providing such skilled students. The importance for computer science and information systems instructors is that their students will benefit from courses informed by industry requirements for skills beyond mere technologies.

The findings are indicating the instructor is functioning not as a lecturer but as a mentor to the students, implying initially less instructor involvement on a problem-based or project-based learning program, which could be a downside for other instructors. However, the instructor in winter / spring 2019 found as in the literature (Miller, 2018) a lot more involvement as a mentor and a motivator on the projects, so that the students were fully functioning gradually but productively on their self-directed spirited teams. The importance for instructors is that a project-based learning syllabus will inevitably necessitate more involvement and motivation one-on-one with students, especially students not previously on self-directed teams.

Lastly, the findings of this paper are indicating that group projects are initially an issue for mostly students not previously on self-directed teams. As novices they have to be helped in learning the importance of interdependence of fellow members of their teams, from the instructor and from the students previously on teams. The interdependence of the information systems or non-information systems students is a prerequisite on the project-based learning tasks of teams (Knutson, 2018). The productivity of the students is influenced prominently if they opt in spiritedly on the tasks of their teams. The final

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v5 n4907

implication for instructors is that the requirements for self-directed teams will necessitate more involvement of not only the instructor as a mentor but also of the students themselves.

7. LIMITATIONS AND OPPORTUNITIES

The findings from the course on Collaborative Design Innovation during the duration of only winter / spring 2019, with a limited number of students, are limitations of this paper. Further limitations include hypothetical imagined organizations for the pseudo projects invented by the student teams. Future paper replication will include more non-pseudo organizational projects, involving more computer science and information systems students partnered with more non-computer science and non-information systems students, as a sample over a period of semesters.

8. CONCLUSION

Collaborative design courses are engaging computer science and information systems students on cross-disciplinary projects. Students are engaging on innovation projects in interdisciplinary self-directed teams, learning divergent points of view. In Collaborative Design Innovation computer science and information systems students are engaging in a learning process with liberal arts, humanities and business students on the teams. In the perceptions of the students, they are learning a marketable repertoire of skills, notably in the responses of the students not previously on teams. Importantly, the computer science and information systems students in this paper are learning to be more than technologists, a finding of significance as such students may be limited as mere niche technologists without Collaborative Design Innovation. This paper informs instructors in the learning process involving all of the students in this study on the self-directed teams. Furthermore, this paper informs instructors on the integral mentoring process involving computer science and information systems professors as motivators of the student teams. In conclusion, the findings of this paper will hopefully inspire instructors in schools of computer science and information systems to integrate the pedagogical practices introduced in this study.

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ISSN: 2473-3857
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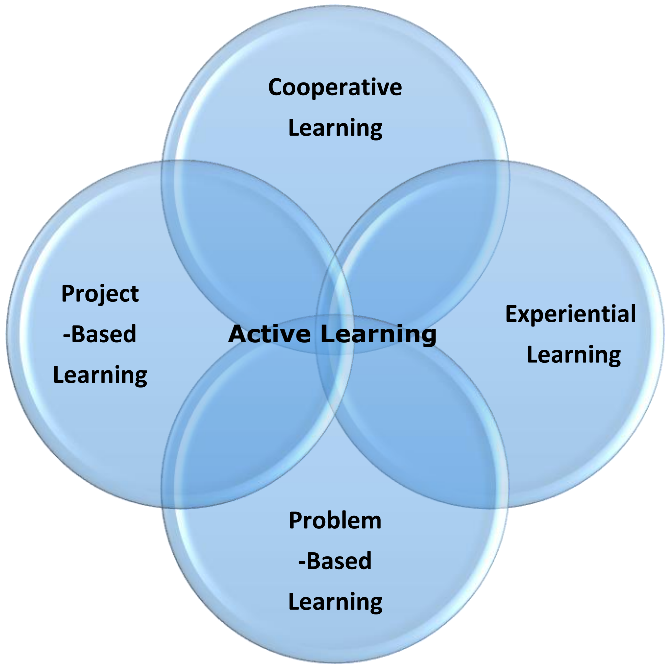
APPENDIX



Active Authentic Design Learning

Figure 1: Concept of Course – *Design Innovation and Thinking* –Seidenberg School of Computer Science and Information Systems

Table 1: Course Outline – *Design Innovation and Thinking* –Seidenberg School of Computer Science and Information Systems

Semester Weeks	**Topics of the Weeks**	**Treks of the Weeks** (Optional)
1	**Orientation** Challenges and Fears - Acquaintance Exercise Collaborative Culture for Design Entrepreneurial Mind and Process - Entrepreneurship Exercise Expectations and Experiences on Design Projects Factors for Innovation Projects Deliverable:	

 ISSN: 2473-3857
v5 n4907

	Preliminary Course Reflection Report (by Student)	
2	**Orientation** Design Factory Methodology - Passion-Driven Processes for Innovation Projects Potential of Inter-Disciplinary Teams on Innovation Projects - Movie: The Purple Heart (Amazon) - Professor Role and Roles of Students Self-Directed Teams	Design Factory Lab (of Aalto University) in Seidenberg School
3	**Organization** Collaboration and Diversity Exercise on Problem Solving Formation of Student Teams (Member Selections by Professor) - Interdependencies of Member Students on Teams Gathering Preliminary Perspectives on Big Ideas (Products) Projects - Marketplace Product Rationales Gathering and Learning Preliminary Requirements – Stage 1 Parameters of Projects (from Professor) Deliverable: *Preliminary Contracts* (Tasks) *of Member Students on Teams* (by Student)	Escape the Room (Groupon)
4	**Organization** Gathering Final Perspectives on Big Ideas (Products) Projects Gathering and Learning Requirements – Stage 2 Deliverables:	Lubin School of Business Entrepreneurship Lab

 ISSN: 2473-3857
v5 n4907

	Mini-Presentations on Preliminary Big Ideas (Products) Projects (by Team) - *10 Second Pitch Presentations* *Entrepreneur Practitioner Research Study (by Student)*	
5	**Process** Brainstorming Exercise: Commute by Wheelchair Brainstorming on Big Ideas (Products) Projects - Customer Differentiation - Differentiation of New Products - Ideas vs. Opportunities of Products Product Development Process Movie: Steve Jobs	
6	**Process** Brainstorming on Big Ideas (Products) Projects Product Development Process	Advisory Board Entrepreneurship Mentor Firm
7	**Process** Brainstorming on Final Big Ideas (Products) Projects Product Development Process Preliminary Big Ideas (Products) Projects (Scenarios) Storyboarding Deliverables: *Celebratory Brainstorming on Final Big Ideas (Products) Projects Breakfast* (by Class) *Final Contracts* (Tasks) *of Member Students on Teams* (by Student) *Mini-Presentations on Final Big Ideas (Products) Projects* (by Team)	

ISSN: 2473-3857
v5 n4907

8	**Process** Big Ideas (Products) Projects (Scenarios) Storyboarding Product Development Process Deliverable: *Journal of Innovation and Entrepreneurship Scholarly Study* (by Student)	WeWork (Workspace)
9	**Process** Final Big Ideas (Products) Projects (Scenarios) Storyboarding Preliminary Product Prototyping (Simulations) - Product Prototype (Features) Specifications Product Development Process Rapid Application Development (RAD) Steps Deliverables: *Celebratory Big Ideas (Products) Projects (Scenarios) Storyboarding Luncheon* (by Class) *Half-Gala Pitch Presentations on Final Big Ideas (Products) Projects (Scenarios) Storyboarding* (by Team)	Advisory Board Entrepreneurship Mentor Firm
10	**Process** Movie: The Dropout – Scam in Silicon Valley (Netflix) Product Development Process Product Prototyping (Simulations) - Product Prototype (Features) Specifications	Application (App) Development Lab in Seidenberg School

 ISSN: 2473-3857
v5 n4907

	Prototyping the Prototype – Stage 1 Rapid Application Development (RAD) and Iteration Steps	
11	**Process** Product Development Process Product Prototyping (Simulations) - Product Prototype (Features) Specifications Prototyping the Prototype – Stage 2 Rapid Application Development (RAD) and Iteration Steps Deliverable: *Mini-Presentations on Interim Product Prototyping (Simulations)* (by Team)	WeWork (Workspace)
12	**Process** Final Product Prototyping (Simulations) Pitch Presentation Standards Product Development Process Rapid Application Development (RAD) Steps Deliverable: *MIT Technology Review Practitioner Research Study* (by Student)	Equity Investor Firm
13	**Production** Final Product Prototyping (Simulations) - Financial Funding Plan for Resources - Member Propositions of Teams - Rewards and Risks of Support	Advisory Board Start-Up Venture

 ISSN: 2473-3857
v5 n4907

	Rapid Application Development (RAD) Steps Deliverable: *Preliminary Gala Pitch Presentations of Product Prototypes* (by Team)	
14	**Production** Deliverables: *Gala Pitch Presentations of Product Prototypes (by Team)* - *Product Project Prototype Walkthroughs (by Team)* *Celebratory Gala Pitch Presentations Dinner* (by Class) *with Dean of Seidenberg School of Computer Science and Information Systems* *Final Project Reflection Reports* (by Student) *Recognitions of Students and Teams* (by Professor)	

Note: Projects are performed by student teams beginning in Organization Week 3.

Note 1: Prototypes may be electronic or paper prototyping simulations.

Table 2A: Course – *Design Innovation and Thinking* – Factor Perceptions of All Students by Discipline Summary – Winter / Spring 2019

	All Students	
	n=27	
	Mean	Standard Deviation
Factors (Skills)		
Collaboration	4.33	1.18
Communication	4.04	1.13
Creative Thinking	4.52	0.80
Critical Thinking	4.33	0.88
Diversity	4.33	0.96
Empathy	3.22	1.65

 ISSN: 2473-3857
v5 n4907

Entrepreneurship	4.56	0.85
Flexibility	3.93	1.11
Management	4.00	1.11
Problem Solving	4.48	0.85
	4.17	1.13

Legend of Rating Scaling: (5) – Very High Impact [from Perceptions of Learned Skills], (4) High Impact, (3) Intermediate Impact, (2) Low Impact, (1) Very Low Impact, and (0) No Impact

Table 2B: Course – *Design Innovation and Thinking* – Factor Perceptions of Students by Discipline Summary – Winter / Spring 2019

	Computer Science and Information Systems Students		**Business Students**		**Liberal Arts Students**	
	n=14		n=6		n=7	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Factors (Skills)						
Collaboration	4.14	1.46	4.50	0.84	4.67	0.58
Communication	3.86	1.41	4.50	0.84	4.33	0.58
Creative Thinking	4.50	0.76	4.67	0.82	4.33	1.15
Critical Thinking	4.36	0.84	4.33	1.03	4.29	0.95
Diversity	4.71	0.73	4.00	1.10	3.86	1.07
Empathy	3.36	1.78	3.17	1.83	3.00	1.41
Entrepreneurship	4.29	0.99	5.00	0.00	4.71	0.76
Flexibility	3.93	1.21	4.33	1.03	3.57	0.98
Management	4.07	1.21	4.33	1.03	3.57	0.98
Problem Solving	4.43	0.94	4.67	0.82	4.43	0.79
	4.16	1.20	4.35	1.05	4.04	1.03

Table 3A: Course – *Design Innovation and Thinking* – Factor Perceptions of Students by Year – Winter / Spring 2019

	Freshman Students	
	n=12	
	Mean	Standard Deviation
Factors (Skills)		
Collaboration	4.25	1.48
Communication	4.17	1.47

 ISSN: 2473-3857
v5 n4907

Creative Thinking	4.58	0.79
Critical Thinking	4.33	0.89
Diversity	4.67	0.78
Empathy	3.00	1.91
Entrepreneurship	4.67	0.78
Flexibility	4.08	1.00
Management	4.33	0.89
Problem Solving	4.58	0.79
	4.27	1.19

Table 3B: Course – *Design Innovation and Thinking* – Factor Perceptions of Students by Year – Winter / Spring 2019

	Sophomore Students		**Junior Students**		**Senior Students**	
	n=7		n=4		n=4	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Factors (Skills)						
Collaboration	4.43	0.98	4.25	0.96	4.50	1.00
Communication	3.71	0.76	3.75	0.50	4.50	1.00
Creative Thinking	4.00	1.00	5.00	0.00	4.75	0.50
Critical Thinking	3.86	1.07	4.75	0.50	4.75	0.50
Diversity	4.43	0.98	3.50	1.00	4.00	1.15
Empathy	3.43	1.62	2.75	1.50	4.00	1.15
Entrepreneurship	4.43	0.98	4.50	1.00	4.50	1.00
Flexibility	3.43	1.40	3.75	0.96	4.50	1.00
Management	3.57	1.51	3.25	0.50	4.50	1.00
Problem Solving	4.43	0.98	3.75	0.96	5.00	0.00
	3.93	1.15	3.93	1.02	4.50	0.85

Table 4: Course – *Design Innovation and Thinking* – Spearman Correlations of Paper – All Students - Winter / Spring 2019

	Collaboration	**Communication**	**Creative Thinking**	**Critical Thinking**	**Diversity**
Communication	0.4793**				
Creative Thinking	-0.0055	0.0998			
Critical Thinking	0.1128	0.2547	0.6822*		

ISSN: 2473-3857
v5 n4907

Diversity	-0.1873	-0.0482	-0.1256	-0.0976	
Empathy	0.2460	0.3522	0.0936	0.2022	0.1507
Entrepreneurship	0.2672	0.7353*	0.0855	0.1757	-0.1890
Flexibility	0.6876*	0.6986*	0.1924	0.3321	-0.1043
Management	0.4941*	0.557*	0.3440	0.2995	-0.0551

	Diversity	**Empathy**	**Entrepreneurship**	**Flexibility**	**Management**
Creative Thinking					
Critical Thinking					
Diversity					
Empathy					
Entrepreneurship		0.2592			
Flexibility		0.5399*	0.5104*		
Management		0.4337**	0.3687	0.6175*	
Problem Solving		-0.1037	0.0714	0.0919	0.3608

Level of Significance = 0.05, with * Signifying a Probability Value Equal or Less Than 0.01 and with ** Signifying a Probability Value Between Greater Than 0.01 But Less Than 0.05

Table 5: Course – *Design Innovation and Thinking* – Frequency Distributions of Paper – All Students - Winter / Spring 2019

	Collaboration	**Communication**	**Creative Thinking**	**Critical Thinking**	**Diversity**
Rating Scaling					
(5) Very High Impact	66.7%	40.8%	70.4%	59.3%	66.7%

ISSN: 2473-3857
v5 n4907

(4) High Impact	11.1%	33.3%	11.1%	14.8%	-
(3) Intermediate Impact	18.5%	22.2%	18.5%	25.9%	33.3%
(2) Low Impact	-	-	-	-	-
(1) No Impact or Blank	3.7%	3.7%	-	-	-

	Empathy	**Entrepreneurship**	**Flexibility**	**Management**	**Problem Solving**
Rating Scaling					
(5) Very High Impact	33.4%	77.8%	44.5%	48.2%	70.4%
(4) High Impact	11.1%	-	11.1%	11.1%	7.4%
(3) Intermediate Impact	25.9%	22.2%	40.7%	37.0%	22.2%
(2) Low Impact	11.1%	-	-	-	-
(1) No Impact or Blank	18.5%	-	3.7%	3.7%	-