

Pandemic Pivoting: Reimagining Entrepreneurial Projects of STEM

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Abstract

COVID-19 affected education at colleges of computer science and information systems. Courses began online at most institutions after the beginning of the pandemic. In this paper, the authors of a collaborative design course in STEM evaluate the impacts of online learning on the entrepreneurial skills of students engaged remotely on self-directed teams. Despite the challenges of the pandemic in learning remotely, the paper essentially finds improvements in entrepreneurial marketable skills of the students, facilitated from flexible and imaginative instructor interventions. The findings from the perceptions of the students will benefit professors in schools of computer science and information systems that are exploring further inclusion of online learning in pandemic and non-pandemic scenarios.

Keywords: curriculum of information systems, entrepreneurship, online learning, pandemic, performance, self-directed teams, science, technology, engineering and mathematics (STEM)

1. BACKGROUND OF PAPER

COVID caused colleges to adjust courses from offline to online platforms, affecting a community of learners (Ellis, 2020). Educators in schools changed delivery of courses for learning to be more remote for students. Facilities consisted of Brightspace, Canvas, Google Talk, Houseparty, Kaltura, Microsoft Teams, Skype, TikTok, Whereby and Zoom, forcing new options for instructors with almost no preparation (Rosensweig & LeBlanc, 2020). Guidelines for learning consisted of a new paradigm for instructors. Essentially, online learning in the

pandemic contributed to difficulties for instructors and students.

Literature cited a community discontinuity in online learning of students in spring 2020. Learning is considered depressing if experienced in not enough face-to-face connection of instructors and students and of students and other peer students that is perceived serendipitous (Lederman, 2020). Feelings of loneliness and non-community are denoted as forming into isolation (Hadley & Mortensen, 2021) and into health issues in the "new normal" for students not in affinity groups of peer students

(Gupta, 2021). Feelings of non-community and non-connection are denoted as forming into issues of motivation for instructors and for students (Lee, 2020). Feelings of distraction and of negativity from non-connection can impact the learning of course skills by students (Lee, 2020), especially if in-home platforms or institutional services are limited or non-existent for inexperienced students (Minero, 2020). Learning of marketable skills can be less in online learning than in offline learning. Findings of negativity can be discouraging for instructors forced into online learning (Gaudiot & Kasahara, 2020). Nevertheless, instructors in schools of computer science and information systems can engage in improvements in online learning from flexible interventions for students.

Colleges can improve online learning practices for students in a pandemic. Community in courses of design can be creatively improved for connection on entrepreneurial group projects in interventions initiated by instructors (Sochacki, 2020). Effective learning does not necessarily have to be in physical scenarios, in contrast to remote scenarios. Online learning on collaborative design projects in STEM, consisting of students on self-directed ideation teams, can impact the learning of marketable skills of students (Thompson, 2021), including the motivation skills of the students. In this paper, the authors contribute findings from a course of collaborative design forced online during the pandemic, in a school of computer science and information systems.

2. INTRODUCTION TO PAPER

From the beginning of COVID-19 in early spring 2020, and the continuing of the pandemic in fall 2020, a 3-credit course of *Collaborative Design in Innovation* of the second author- professor converged from face-to-face to online learning at the Seidenberg School of Computer Science and Information Systems of Pace University. The course converged as a hybrid on the Bright Space (NCE.HE.20.04.02) learning management system and as largely synchronous on <https://zoom.us> (Brennan, 2021). Foundationally, *Collaborative Design in Innovation* is an active learning cross-disciplinary course, engaging students on entrepreneurship projects of STEM (Gans, 2020) as designer interdependent members of self-directed teams (De Paula, 2020), for 14 semester

Tuesdays. As documented in Figure 1 of the Appendix, the goals of the course are for the students to learn entrepreneurial skills – important interpersonal skills (Sabin, et.al., 2017) – from interactions with multidisciplinary students (Hargadon & Bechky, 2006). Critically, the professor is a catalyst or helper – “how can I help you?” – not a lecturer – “do this!” (Hancock, et.al., 2002), as the students develop the projects as members of their teams from guidelines of a prescribed text (Bjorklund, et.al., 2017).

The circumstances of a course as *Collaborative Design in Innovation* as conveniently designed as face-to-face physical forced to remote can be challenging for a professor (Boardman, et.al., 2020). Community can be a concern in a course of cross-disciplinary projects interdependently reliant on self-directed student zoom teams. Cross-disciplinary projects can be a concern as students are not only from a school of information systems but also from schools of business and liberal arts that have to interface with information systems students on STEM teams. Effectiveness of outcomes can be a concern on projects from which students might have learned marketable skills (Karaevli, et.al., 2021) more in in-person physical than remote on zoom. The conditions of a pandemic do not improve the isolation of learning remotely from a course custom-designed as in-person physical but initiated on self-directed teams through videoconferencing on zoom.

For the circumstances of COVID-19, the course professor customized the course design. For the n=23 spring 2020 and n=24 fall 2020 students in *Collaborative Design in Innovation*, the professor continued from pre-pandemic fall 2019 to determine the member students of the self-directed teams (n=5 students per teams) from a diversity of the schools. From the pandemic semester of spring 2020, n=12 liberal arts, n=7 business and n=4 information systems students integrated into the teams, and from the semester of fall 2020, n=9 information systems, n=9 liberal arts and 6 business students integrated their teams. Concurrently, from spring 2020, n=9 junior, n=5 senior, n=5 sophomore and n=4 freshmen students integrated into the teams; and from the semester of fall 2020, n=9 junior, n=9 sophomore, n=5 senior and n=1 freshman students integrated into their teams, an essentially experienced blend of students. Following guidelines of the professor and the text,

the students determined the applications (apps) –entrepreneurship - projects of mutual interest to them (n=5 projects per semester teams) to be finished at the end of the semesters, focusing on “breakthrough” apps of business (e.g., app for clothing delivery), health (e.g., app for COVID-19 appointments), and social (e.g., app for elderly help) projects for helping disadvantaged pandemic-impacted populations.

Importantly, the professor designed the course in the pandemic semesters to emphasize his empowerment of the students to engage as entrepreneurs essentially experimenting on the projects determined by them (Baeten, et.al., 2010). He emphasized flexibility to the needs of the students in fulfilling incrementally the projects, emphasized freedom in fulfilling iteratively their projects at the pace of their teams (Lowe, 2020) and energized one-on-one interactions of the students with himself and other peer students. For example, he initiated interventions for the online sessions, as in the below semester snapshot for each of the fall 2020 14 Tuesdays:

- 9:50 AM – 10:05 AM
Good Morning Music! (Optional) with Professor

- 10:05 AM – 10:20 AM
General Session (All Students)
Birthday Congratulations!
Good Morning Icebreaker Jolt!
Exercise for Mediation Mindfulness
Agenda of Class (Assignments for Projects by Teams)
Questions for Deliverables for Class

- 10:20 AM – 11:40 AM
Breakout Sessions (Self-Directed Teams)
Design, Development and Implementation of Projects by Students and Teams
-Storyboarding and Prototyping of Projects by Students and Teams
Guest Presenters on Extra-Curricular Programs of Schools
Mini-Presentations of Progress of Project Previews by Teams
Observation by Professor (and Participation if Requested by Teams)

- 11:40 AM – 12:05 PM
General Session (all Students)
Mini-Presentations of Progress of Projects by Teams

Questions on Projects by Other Teams
Questions for Deliverables for Next Class
Good Afternoon Icebreaker Jolt!

- 5:00 PM – 7:00 PM
Happy Hours (Non-Alcoholic and Optional) with Professor!

The professor integrated the interventions to relax the students isolated in the online sessions each Tuesday on zoom, especially a few of the students (n=7 students) joining from locations beyond the metropolitan New York region. Nevertheless, he had agreed deliverables from the *Collective Design in Innovation* guidelines on PowerPoints for the self-directed teams each Tuesday on zoom. Moreover, he monitored the progress of the projects from blog (contract) postings by the students each Tuesday on the Bright Space system, mini-presentations of the projects by the teams each Tuesday on zoom, and monthly reflection reports by the students on the Bright Space system (Spears, 2018), and from notably observations in the breakout rooms on zoom (Hazzan, 2020); and the students monitored the progress of their projects and skills in the sessions of their teams, pacing themselves each Tuesday on zoom. Overall, the professor cognitively and emotionally functioned as a mentor to the students, as needed by the students and teams, in and out of the sessions for the weeks.

In this paper, the authors attempt to evaluate impacts of the *Collaborative Design in Innovation* course in the initial pandemic period. The authors evaluate the impacts of learning remotely on the entrepreneurial skills of the students. Importantly, the authors evaluate the learning from the skills in this period to the learning physically in the pre-pandemic fall 2019 semester. Improvements in interventions of the professor in learning remotely on zoom may or may not be evident in the pandemic spring and fall 2020 students. The findings from this paper will contribute input as to optimal remote teaching through videoconferencing on zoom.

3. FOCUS OF PAPER

The emphasis is to evaluate the impacts of the learning in the pandemic in the perceptions of the *Collaborative Design in Innovation* students. The focus is on the online learning of entrepreneurial, essentially interpersonal, marketable skills

intended for the spring and fall 2020 students. The factors of this paper are outcomes of skills from a pre-pandemic paper of the authors (Lawler & Joseph, 2020) and from other sources as below:

- Collaboration (Bjorklund, et.al., 2017) – factor from which students perceive improved fruitful engagement skills;
- Communication (Gedeon & Valliere, 2018) – factor from which students perceive increased interaction and listening skills with other students;
- Community – factor from which students perceive increased conjoint connection with other students, notably in the pandemic (Lawler & Joseph, 2020);
- Creative Thinking (Felder & Brent, 2016) – factor from which the students perceive increased experimental ideation skills with other students on their self-directed teams;
- Critical Thinking (Felder & Brent, 2016) – factor from which the students perceive increased interpretative logical skills;
- Diversity (Bjorklund, et.al., 2017) – factor from which students perceive increased intercultural interdisciplinary skills with other students;
- Emotional Intelligence (Coleman, 2005) – factor from which students perceive increased interpersonal relationship skills with other peer students;
- Empathy (Bjorklund, et.al., 2017) – factor from which the students perceive increased interpersonal sensitivity skills with other students on their teams;
- Entrepreneurship (Gedeon & Valliere, 2018) – factor from which students perceive increased improvised influencing skills on innovation options with other students and increased persuasion skills on their teams;
- Flexibility (Gedeon & Valliere, 2018) – factor from which the students perceive increased group negotiation and perspective skills, notably in stressful situations;
- Management (Gedeon & Valliere, 2018) – factor from which the students perceive increased organizational and personal planning skills, such as time management;
- Motivation –factor from which students perceive increased perseverance in productivity with other students, notably in the pandemic (Lawler & Joseph, 2020); and
- Problem Solving (Felder & Brent, 2016) – factor from which the students perceive increased optimal resolution skills on their teams.

The factors are enhanced for community and for motivation for further improvements in the pandemic skills of the students. The skills of this study are evaluated in the perceptions of the learning of the computer science and information systems students and of the business and the liberal arts students of the university. The findings of this new study will be helpful to professors in courses of design in pandemic, and moreover non-pandemic, scenarios of teaching.

4. METHODOLOGY OF PAPER

The authors evaluate the interdisciplinary perceptions from *Collaborative Design in Innovation* in the pandemic spring and fall 2020 semesters in the Seidenberg School of Computer Science and Information Systems of Pace University.

For a quantitative study, the authors evaluate the online learning perceptions of the n=23 and n=24 students in the spring and fall 2020 semesters from the earlier listed n=13 skills. The students furnished their perceptions of the skills from the online projects of STEM from an anonymous Likert-like survey, ranging and rating the skills from a very high (5) to a very low (1), or a zero (0), and from n=6 yes or no statements, at the end of the semesters. The perceptions of the skills from learning remotely, at the end of the pandemic 2020 semesters, were evaluated further to the perceptions of learning physically of peer students (Lawler & Joseph, 2020), at the end of the pre-pandemic fall 2019 semester.

From the study, the authors interpret the findings of the survey of the students in Microsoft Excel V16.0 and IBM Statistics V24.0 (Adams & Lawrence, 2019), and the results are in the following section.

5. DISCUSSION OF FINDINGS FROM PAPER

The findings from the on-line pandemic semesters of spring and fall 2020 are encouragingly favorable from the perceptions of the *Collaborative Design in Innovation* students. Despite the challenges of the semesters, the perceptions are favorable in the learning of marketable skills. The perceptions of the all 24 students are favorably high in fall 2020 as they are of the all 23 students in spring 2020 when the students were forced immediately to be on zoom.

Though favorable, the pandemic perceptions are not as favorably higher as the pre-pandemic perceptions of the skills of the 26 fall 2019 students (Lawler & Joseph, 2020), as highlighted in Table 1 of the Appendix. Favorability in learning remotely is evident nevertheless in the perceptions of the computer science and information systems students and of the liberal arts and business students and is highlighted in Tables 2 and 3.

The findings are highlighting the pandemic perceptions of the 13 computer science and information systems students in fall and spring 2020 of collaboration (means=4.78 [fall] and 5.00 [spring] /5.00) to problem solving (4.78 and 4.75) learned skills. The perceptions of the 13 computer science and information systems students are especially highlighting the fall and spring 2020 community (4.44 and 4.75) and motivation (4.78 and 5.00) skills. The pandemic perceptions of the consolidated 21 liberal arts and 13 business students are highlighting in fall and spring 2020 of collaboration (3.80 and 3.79) to problem solving (4.20 and 3.32) learned skills. The perceptions of the consolidated 21 liberal arts and 13 business students are highlighting the fall and spring 2020 community (3.53 and 3.16) and motivation (4.53 and 4.11) pandemic skills. The full perceptions of the skills of the students are indicated in Tables 2 and 3.

The findings are further highlighting the pandemic perceptions of the 13 computer science and information systems students in fall and spring 2020 to the pre-pandemic perceptions of the 11 information systems students in fall 2019. The perceptions of the more experienced in on-line 13 information systems students from the projects in fall 2020 are generally similar to the perceptions of the 11 information systems students from their projects of STEM in fall 2019 (Lawler & Joseph, 2020), from collaboration (4.78 [2020] and 4.50 [2019]) to problem solving (4.78 and 4.35) learned skills; the perceptions of the consolidated less experienced on-line liberal arts (21) and business (13) students from the projects in fall and spring 2020 are not as similar to the consolidated liberal arts (7) and business (7) students in fall 2019, from collaboration (3.80 and 4.29) to problem solving (4.20 and 4.50) skills. These findings are indicated in Tables 2 and 3.

As to the findings of the pandemic particular perceptions of the skills, in the fall and spring 2020 semesters, the perceptions of respectively the all 24 and all 23 students are highlighting collaboration (4.17 and 4.00), communication (4.33 and 4.09), creative thinking (4.46 and 4.39), critical thinking (4.46 and 4.35), diversity (4.46 and 4.48), emotional intelligence (4.29 and 4.22), empathy (4.13 and 4.09), entrepreneurship (4.42 and 4.09), flexibility (4.00 and 3.91), management (4.54 and 3.96), and problem solving (4.42 and 3.57), and particularly community (3.88 and 3.43) and motivation (4.63 and 4.26) which the author-professor included in this new study. These findings are indicated in Table 1. The perceptions are further indicated in statements of summations in Tables 4 and 5. Finally, the professor graded the students an average final grade of A- / B+ in the fall and spring 2020 sessions, as few of them opted for a P / F option of the university.

Lastly, the pandemic perceptions of the fall 2020 semester are consolidated in the correlations and frequency distributions of the learned skills of the students in Table 6 and Table 7.

6. IMPLICATIONS OF PAPER

"You can feel ... fearful and ... resentful and simultaneously be ... resilient and a victim. Reminding people [students] that they are both is extremely important." – Mana Ali, MelStar National Rehabilitation Hospital, Washington, D.C.

Despite the challenges of the pandemic, a camaraderie community is apparent in the learning of the students. Collective creativity in engaging in the interdependent projects of the students is clear in the online learning of the students. Commonality in the entrepreneurial missions of the projects is evident in the online learning felt by the *Collaborative Design in Innovation* computer science and information systems students, in the pandemic semesters. Connection is evident in the perceptions of the liberal arts and the business students on the cooperative projects of STEM, shared with the information systems students on their self-directed teams. On-camera connection in a "speak-up environment" is even evident from a high number of the students, from class and non-

class sessions of their teams. Even in a pandemic, the feasibility of community in online learning is an implication of the paper.

Effective engagement online is a characteristic of the entrepreneurial projects of the students. Especially into the fall 2020 pandemic semester, the learning of motivation skills is evident in the perceptions of the students. Experiential learning on the online projects of STEM is evident increasingly in the learning of the motivation skills of the students (Hanrahan, 2020), notable in the "I can do this" perceptions of the computer science and information systems students and of the business and liberal arts students. "Fatigue" is not evident from lecturing the students "to do this", as the instructor was not a lecturer to them (Saint James & Campbell, 2020). Few of the students hesitated in initiating the on-line projects from the pandemic spring 2020 semester, as most of them indicated passion and satisfaction in the mutual project selections of their teams (Napier & Johnson, 2007). Even in the difficulties, the feasibility of pandemic perseverance in the resilience of the students is an implication of this paper.

Entrepreneurship is a characteristic in the learning of the interpersonal skills of the students. Favorability in the impacts of the online learning of the soft skills is evident in the perceptions and the statements of the students. Outcome perceptions of collaboration, communication, creative thinking, critical thinking, diversity, emotional intelligence, empathy, entrepreneurship, flexibility, management and problem solving skills are found from the projects of STEM, in the pandemic semesters as generally in the pre-pandemic semesters, from the students. Perceptions of membership of self-directed teams are fulfilling perceptions of productive team playing. The computer science and information systems students are learning online marketable skills beyond mere skills of technology. The impacts of improvements in the learning of the students in pandemic remote scenarios is a further implication of this study.

Experimentation in online learning in a pandemic is a consuming duty for a professor, higher indeed than in physical scenarios. Casual discussable jolts in "around the room" sessions are favorable for students (Herman & Nilson, 2018). Having

the projects done in simple steps in each of the breakout sessions – "small things" – are ideal interventions. Interventions are critical in the online learning of students (Darby, 2019). Learner motivation in a pandemic is critical in outreach of professors to students that might have pedagogical or personal problems (Moyer, 2021), or other problems of remote technology that might not be infrequent of liberal arts and business students on zoom. A lot more than in physical scenarios, professors have to err in favorability and flexibility for their students (Deacon, 2012), and they have to be on-camera real and "to be there" interacting on student terms throughout the weeks (Zhou, 2015). The flexible – humanity - interventions of professors as necessary online in pandemic or non-pandemic remote scenarios are an implication of this study.

Facilitating online learning is critical and crucial especially in pandemic scenarios. Instruction is frequently an asynchronous and synchronous learning model (Gardiner, 2020), as in the School of Computer Science and Information Systems. Fundamental institutional resources of staff are necessary for professors and students (Ladyzhets, 2021), and services of internal technologists are needed for professors and students for online learning quality from systems and videoconferencing on zoom (Riggs, 2019), which were positively received by most of the pandemic students. If mutations from the pandemic are in the future, new remote telepresence technologies might be needed beyond zoom (Marks, 2020). The final implication of this study is that internal services of a university are needed for the online learning quality of courses as *Collaborative Design in Innovation* that are dependent on systems technologists.

7. LIMITATIONS AND OPPORTUNITIES

The paper is limited in its relatively small sample of students. This paper is further limited in its findings of one course of one school of students of one university. The findings of this paper as to the general perceptions of positivity of the students may not be generalizable to other institutions, especially as most of the students were influenced in their performance on the projects remotely by the high quality of services of the internal technologists of the university. Nevertheless, this paper will be helpful to

professors in imaginatively initiating interventions in the online learning of their students. Essentially, this paper introduces opportunities for pandemic and non-pandemic scenarios for professors and students.

8. CONCLUSION OF PAPER

COVID-19 caused *Collaborative Design in Innovation* to be conducted online in the pandemic. Findings from the paper denote effective improvements in general in entrepreneurship learning of marketable skills of online pandemic students, essentially following findings of physical pre-pandemic semester students. Learning improvements in the skills of the online pandemic computer science and information systems students are denoted in the paper. Important in the paper are the improvements in the community and motivation skills of the on-line pandemic students, facilitated from the imaginative interventions of the professor. *Collaborative Design in Innovation in STEM* is a course in which the professor is deliberately not an impersonal lecturer, but a mentor to the students, who in the pandemic were on projects of multidisciplinary remote self-directed teams. Outreach of the professor in a crisis as a pandemic is crucial in personal sensitivity to the students. Findings are indicating moreover the perseverance and the resilience of the computer science and information systems students, and the business and the liberal arts students, despite the obstacles of learning remotely in the semesters. In conclusion, this paper contributes apt insight that will be helpful to professors re-imagining remote teaching in non-pandemic and pandemic scenarios for their students.

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APPENDIX

Pace University
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Collaborative Design in Innovation
Learning Objectives for Pandemic Spring 2021

- Experience collaborative and cross-disciplinary dynamics in designs of applications (apps) “breakthrough” entrepreneurship projects;
- Experience design factory methodology on ideation incremental processes of project storyboarding and prototyping simulations;
 - Experience and learn entrepreneurial marketable skills of collaboration, communication, community, creative thinking, critical thinking, diversity, emotional intelligence, empathy, entrepreneurship, flexibility, management, motivation and problem solving, on multi- disciplinary self-directed teams;
- Experience design factory methodology on the formation of business, health and social entrepreneurship projects and potential prototyping solutions for disadvantaged pandemic-impacted populations; and
- Experience entrepreneurship pitch presentations of functional product prototyping solutions as if to angel investors and venture capitalists.

Note: Course will be conducted in pandemic spring 2021 on <https://xxxxx.zoom.us>.

Figure 1: Collaborative Design in Innovation
Table 1: Collaborative Design in Innovation Factor Perceptions of Skills – All Students

Factors (Skills) of Study	Pandemic				Pre-Pandemic	
	Spring 2020 (n=23)		Fall 2020 (n=24)		Fall 2019 (n=26)	
	Means	Standard Deviations	Means	Standard Deviations	Means	Standard Deviations
Collaboration	4.00	1.508	4.17	1.308	5.00	0.81
Communication	4.09	1.311	4.33	1.049	5.00	0.70
Community	3.43	1.273	3.88	1.484	-	-
Creative Thinking	4.39	0.891	4.46	0.932	5.00	0.43
Critical Thinking	4.35	0.935	4.46	0.833	5.00	0.63
Diversity	4.48	0.947	4.46	0.884	4.00	0.94
Emotional Intelligence	4.22	0.998	4.29	0.908	4.00	0.89
Empathy	4.09	0.996	4.13	0.992	4.00	0.94
Entrepreneurship	4.09	1.276	4.42	0.881	5.00	0.69
Flexibility	3.91	1.164	4.00	1.285	4.00	0.96
Management	3.96	0.976	4.54	0.833	4.00	0.91
Motivation	4.26	0.915	4.63	0.770	-	-
Problem Solving	3.57	1.502	4.42	1.176	4.00	0.85

Legend of Scaling: (5) Very Impact, (4) High Impact, (3) Intermediate Impact, (2) Low Impact, (1) Very Low Impact, and (0) Impact Null

Note: Community and Motivation Skills are additions in current study.

Note 1: Pre-Pandemic Means and Standard Deviations are in (2020) Lawler & Joseph study.

Table 2: Collaborative Design in Innovation Factor Perceptions of Skills – Computer Science and Information Systems Students

Factors (Skills) of Study	Pandemic				Pre-Pandemic	
	Spring 2020 (n=4)		Fall 2020 (n=9)		Fall 2019 (n=11)	
	Means	Standard Deviations	Means	Standard Deviations	Means	Standard Deviations
Collaboration	5.00	0.00	4.78	0.67	4.50	0.81
Communication	4.50	1.00	4.78	0.67	4.62	0.70
Community	4.75	0.50	4.44	0.88	-	-
Creative Thinking	5.00	0.00	5.00	0.00	4.77	0.43
Critical Thinking	5.00	0.00	5.00	0.00	4.65	0.63
Diversity	4.00	1.15	4.33	1.00	4.19	0.94
Emotional Intelligence	4.00	1.15	4.33	1.00	4.35	0.89
Empathy	3.50	1.00	4.33	1.00	4.38	0.94
Entrepreneurship	5.00	0.00	5.00	0.00	4.65	0.69
Flexibility	4.50	1.00	4.33	1.00	4.27	0.96
Management	4.50	1.00	5.00	0.00	4.23	0.91
Motivation	5.00	0.00	4.78	0.67	-	-
Problem Solving	4.75	0.50	4.78	0.67	4.35	0.85

Table 3: Collaborative Design in Innovation Factor Perceptions of Skills – Business and Liberal Arts Students (Consolidated)

Factors (Skills) of Study	Pandemic				Pre-Pandemic	
	Spring 2020 (n=19)		Fall 2020 (n=15)		Fall 2019 (n=15)	
	Means	Standard Deviations	Means	Standard Deviations	Means	Standard Deviations
Collaboration	3.79	1.58	3.80	1.49	4.29	0.91
Communication	4.00	1.37	4.07	1.18	4.57	0.76
Community	3.16	1.21	3.53	1.70	-	-
Creative Thinking	4.26	0.93	4.13	1.10	4.71	0.47
Critical Thinking	4.21	0.98	4.13	0.95	4.57	0.65
Diversity	4.58	0.90	4.53	0.85	4.43	0.94
Emotional Intelligence	4.26	0.99	4.27	0.89	4.21	0.98
Empathy	4.21	0.98	4.00	1.00	4.43	0.94
Entrepreneurship	3.89	1.33	4.07	0.96	4.57	0.76
Flexibility	3.79	1.18	3.80	1.48	4.14	1.03
Management	3.84	0.96	4.27	0.97	4.14	0.95

Motivation	4.11	0.94	4.53	0.85	-	-
Problem Solving	3.32	1.53	4.20	1.42	4.50	0.77

Table 4: Collaborative Design in Innovation Statements of Summation – All Students

Statements	Pandemic	
	Spring 2020 (n=23)	Fall 2020 (n=24)
I am proud of the product from my project	yes 21 no 2	yes 22 no 2
I am positive from what I learned from my project	yes 20 no 3	yes 23 no 1
I am overall positive of what skills I learned in the semester	yes 16 no 7	yes 18 no 6
I believe despite the pandemic the project was fun in the semester	yes 14 no 9	yes 16 no 8
I was intimidated by learning remotely in the semester	yes 12 no 11	yes 7 no 17
I would like to participate in the international semester version	yes 14 no 9	yes 14 no 10

Table 5: Collaborative Design in Innovation Statements of Summation – Computer Science and Information Systems Students

Statements	Pandemic
	Spring 2020 & Fall 2020 (n=13)
I am proud of the product from my project	yes 12 no 1
I am positive from what I learned from my project	yes 13 no 0
I am overall positive of what skills I learned in the semester	yes 12 no 1
I believe despite the pandemic the project was fun in the semester	yes 12 no 1
I was intimidated by learning remotely in the semester	yes 0 no 13
I would like to participate in the international semester version	yes 10 no 3

Table 6: Collaborative Design in Innovation Correlations of Study – All Students

Factors (Skills) of Study	Pandemic					
	Fall 2020 (n=24)					
	Collaborate	Communicate	Community	Creativity	Criticality	Diversity
Collaboration	-	-	-	-	-	-
Communication	0.799**	-	-	-	-	-
Community	0.653**	0.472*	-	0.119	0.180	0.455*
Creative Thinking	0.472*	0.737**	-	-	-	-
Critical Thinking	0.586**	0.654**	-	0.897**	-	-
Diversity	0.374	0.410*	-	0.052	-0.005	-

Emotional Intelligence	0.417*	0.471*	-	0.242	0.303	0.605**
Empathy	0.214	0.426*	-	0.368	0.231	0.686**
Entrepreneurship	0.583**	0.488*	-	0.326	0.469*	0.339
Flexibility	0.715**	0.633**	-	0.367	0.517**	0.404*
Management	0.634**	0.410*	-	0.259	0.505**	0.375*
Motivation	0.362	0.376	0.426*	0.175	-	0.553**
Problem Solving	0.268	0.100	-	0.097	0.240	0.059

Factors (Skills) of Study	Pandemic						
	Fall 2020 (n=24)						
	Emotion	Empathy	Entrepreneur	Flexibility	Manage	Motivate	Solving
Collaboration	-	-	-	-	-	0.133	-
Communication	-	-	-	-	-	-	-
Community	0.522**	0.376	0.254	0.464*	0.313	-	0.458*
Creative Thinking	-	-	-	-	-	-	-
Critical Thinking	-	-	-	-	-	-	-
Diversity	-	-	-	-	-	-	-
Emotional Intelligence	-	-	-	-	-	-	-
Empathy	0.563**	-	-	-	-	-	-
Entrepreneurship	0.309	0.056	-	-	-	-	-
Flexibility	0.495*	0.329	0.478*	-	-	-	-
Management	0.457*	0.129	0.829**	0.579**			
Motivation	0.399*	0.528**	0.306	0.153	0.318		0.194
Problem Solving	0.401*	0.328	0.201	0.528**	0.381		

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

Table 7: Collaborative Design in Innovation Frequency Distributions of Study – All Students

Factors (Skills) of Study	Pandemic					
	Fall 2020 (n=24)					
	Collaborate	Communicate	Community	Creativity	Criticality	Diversity
(5) Very High Impact	14	16	11	17	15	17
(4) High Impact	3	2	4	2	4	1
(3) Intermediate Impact	6	4	7	4	5	6
(2) Low Impact	1	2	-	1	-	-

(1) Very Low Impact	-	-	2	0	0	0
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Factors (Skills) of Study	Pandemic						
	Fall 2020 (n=24)						
	Emotion	Empathy	Entrepreneur	Flexibility	Manage	Motivate	Solving
(5) Very High Impact	13	13	15	12	17	19	16
(4) High Impact	4	1	3	1	1	1	4
(3) Intermediate Impact	7	10	6	10	6	4	3
(2) Low Impact	-	-	-	-	-	-	-
(1) Very Low Impact	-	-	-	1	-	-	1