AC 2012-3634: CREATIVITY, INNOVATION, AND INGENUITY SUMMER ENRICHMENT PROGRAM: ASSESSMENT FROM A MULTI-INSTITUTIONAL COLLABORATION

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Creativity, Innovation, and Ingenuity Summer Enrichment Program – Assessment from a Multi-Institutional Collaboration

Abstract

A week-long summer enrichment program (i.e., summer camp) was developed for and administered to undergraduate engineering students. The program is the result of a multi-institutional partnership, in which six universities spanning the U.S. collaborate on instilling the entrepreneurial mindset into engineering education. Therefore the camp engaged students from multiple institutions and engineering disciplines. The plan is for three of the six collaborating universities to host an enrichment opportunity over three consecutive summers that focus on entrepreneurial education themed to the unique attributes of the host city. The first summer enrichment program was hosted at Lawrence Tech University who partnered with The Henry Ford in the Detroit metro area. The first camp was focused on exploring creativity, innovation, and ingenuity as it relates to the American experience and manufacturing. In addition to learning objectives, a goal of the program is to demonstrate the curricular enhancement of engaging multiple institutions in interdisciplinary problem solving and to inspire students by showing them the history of innovation in technology and manufacturing. In subsequent summers, two of the partner universities will host summer enrichment opportunities in Boston and St. Louis.

Throughout the week, the camp participants explored the core competencies of creativity and innovation through activities and games. In addition, the students studied and implemented various methodologies of creative problem solving through teamwork on various problems and product development projects/tasks. To further emphasize innovation as it relates to American history, two of the five days were spent visiting The Henry Ford which includes the Henry Ford Museum, Greenfield Village, a Ford F-150 truck assembly plant, and the Benson Ford Research Center where they participated in a pilot version of the new Henry Ford Innovation 101 curriculum.

This paper will explain the objectives and format of the program, summarize the benefits of a multi-institutional engagement and interdisciplinary collaboration, and present assessment results. Two different assessments were performed. First, for the beginning and end of the week, a pre and post-test was conducted to determine the students' general perceptions of creativity, problem solving, teamwork, leadership, the role of creativity in engineering, and their personal view on their own creativity. A comparison of the pre and post-program surveys yields a shift in perceptions. A second assessment administered to the students at the conclusion of the week gives an analysis of the effectiveness of the program, the delivery techniques, and the format.

1. Introduction

Lawrence Technological University (LTU) has offered engineering students entrepreneurial education programs for many years. Recognizing that graduates entering industry will require business and entrepreneurial skills, the College of Engineering developed an entrepreneurial certificate program and founded the Lear Entrepreneurial Center. The entrepreneurial certificate

program develops student skills in communication and business components in the engineering profession and includes a multi-disciplinary capstone design experience for which teams are eligible for student venture grants administered by the institution. Several multi-year grants have strengthened the program through workshops, keynote speakers, faculty curriculum awards, student venture grants, and faculty incentives to work with industry sponsored student teams. Specifically, the College of Engineering received an invitation to participate as part of a larger initiative to develop the Kern Entrepreneurship Education Network (KEEN). The invitation also provided funding to develop and integrate entrepreneurial (and leadership) education across the curriculum.

The goal of KEEN is to make entrepreneurship education opportunities widely available at institutions of higher learning, and to instill an action-oriented entrepreneurial mindset in engineering, science, and technical undergraduates. The skills associated with the entrepreneurial mindset are communication, teamwork, leadership, ethics and ethical decision-making, opportunity recognition, persistence, creativity, innovation, tolerance for ambiguity, risk analysis, creative problem solving, critical thinking, and business skills (including marketing, financial analysis, and strategic planning).[1, 2, 3, 4] The network is limited to private institutions with ABET accredited engineering programs and is by invitation only.

As of January 2012, KEEN includes twenty institutions across the U.S. The KEEN program provides access to vital resources for building quality entrepreneurship education programs that engage engineering and technical students including grants, faculty fellowships, capacity building workshops, networking opportunities, and resources. More specifically, KEEN provided financial and developmental resources to grantee institutions for the development of entrepreneurship curricula, modules, and extracurricular activities like business plan competitions, speaker series, student entrepreneurship clubs, and seminars.

In addition, to the broader network, subsets of the 20 institutions formed smaller "dense" networks to foster additional dependency and collaboration. The dense networks can collaborate on more elaborate entrepreneurship education opportunities using resources that have been fully-developed from many years of experience. The first of these dense networks is referred to as the Dynamic Compass Network (DCN) which consists of six universities: Boston University, Gonzaga University, Kettering University, Lawrence Tech, St. Louis University, and Worchester Polytechnic Institute.

As one of the initiatives for the DCN, three of the six collaborating universities will each host a week-long summer enrichment program (i.e., summer camp) over three consecutive summers. Each of the six institutions will send undergraduate engineering students to the summer program; therefore each camp will engage students from multiple institutions and engineering disciplines. Each enrichment opportunity focuses on entrepreneurial education themed to the unique attributes of the host city. The first summer enrichment program was developed and hosted by Lawrence Tech who partnered with The Henry Ford, both of which are located in the Detroit metro area. As a result, Lawrence Tech's camp was focused on exploring creativity, innovation, and ingenuity as it relates to the American experience and manufacturing. In subsequent summers, Boston University and St. Louis University will host summer enrichment opportunities

in their respective metro areas. (Themes, details, and objectives for the Boston and St. Louis camps had not been finalized by the time of publication of this paper.)

2. Lawrence Tech Summer Enrichment Program

The Detroit metro area is well known as being the world's automotive industry capital and is nicknamed the Motor City. The three largest American automobile companies (known as The Big Three) are headquartered in the Detroit area: General Motors, Ford Motor Company, and Chrysler. Henry Ford, founder of the Ford Motor Company in 1903, refined and popularized the assembly line and was the first to master the moving assembly line which ultimately transformed mass production and manufacturing (e.g., reduced labor hours required to produce a single vehicle, increased production numbers and parts, lower unit cost, etc.).[5] In addition, Henry Ford was an inventor interested in materials science and engineering; he was awarded 161 U.S. patents. Also, Ford collected and preserved U.S. artifacts mostly themed to practical technology, and consequently developed Greenfield Village and the Henry Ford Museum, one of the most popular American historical tourist destinations. Taking these aspects of Detroit into consideration with the goal of instilling engineering students with the entrepreneurial mindset (particularly creativity, innovation, teamwork, creative problem solving, and critical thinking), it was natural for the Lawrence Tech summer enrichment camp to be themed as "Creativity, Innovation, and Ingenuity in America."

As with leadership, some wonder if creativity and innovation can be taught or if it is a gift that one either does or does not possess. It has been widely proven that creativity can be taught at all levels of education.[6,7,8,9] Creativity and creative problem solving have specifically been taught successfully in engineering curricula for years.[10,11,12] A review of teaching creativity in engineering and the need to do so has been done by Stouffer et al.[6] and is beyond the scope of this paper.

For the Lawrence Tech camp, undergraduate engineering students were identified by each DCN institution. Only rising sophomores through seniors were invited so that all of the students had at least one year of engineering education. Ultimately, 23 students from 13 states attended with majors in biomedical engineering, computer engineering, construction engineering technology, civil engineering, electrical engineering, engineering management, engineering/alternative energy technology, environmental engineering, and mechanical engineering. Five students were sophomores, seven were juniors, and eleven were seniors. The residential camp ran for a week in August just prior to participating institutions fall semester and included housing, all meals, program events, and evening entertainment free of charge to the students. Each institution covered their students' travel costs while Lawrence Tech covered all additional camp costs. The total cost of the residential portion of the camp was $10,381 with additional University matching funds associated with donated University personnel time and free use of campus housing.

Despite exposure at their respective institutions, many students had a gap in learning experiences that promote creativity and innovation in problem solving and the engineering design process. The most successful entrepreneurs and entrepreneurial engineers are typically those that have creatively identified a need and continuously use creative problem solving to stay on the cutting edge and develop new ventures/products/solutions. Therefore, the week's instruction was

designed to progressively build from the foundations of the creative process/competencies to the application of innovative techniques and creative problem solving (coupled with engineering design). Monday's theme was creativity, Tuesday focused on ingenuity, Wednesday focused on innovation, and Thursday/Friday focused on applying the creative problem solving/design process (see also Table 1).

3. The Program Structure and Content

The first, fourth, and fifth days of instruction was administered at and by Lawrence Tech. The second and third days were administered at and in conjunction with The Henry Ford (which includes the Henry Ford Museum, Greenfield Village, the Ford F-150 truck assembly plant, and the Benson Ford Research Center).[13]

The objectives of the program are upon completion of the week-long program, the student will be able to:

1. use techniques/competencies to inspire creativity.
2. define invention, innovation, and discovery.
3. identify the various processes of innovators.
4. use a variety of creative problem solving methodologies or strategies.
5. approach and analyze unfamiliar situations and open-ended problems while using various methods to define the "true" problem (i.e., real versus perceived).
6. assess the constraints, benefits, and risks of problems and their various solutions.
7. formulate a plan of action for solving problems following various methodologies.
8. formulate multiple creative solutions to a given problem or design.
9. interact confidently in a multi-disciplinary team.

Various teaching and learning strategies were implemented to reach the objectives. While there were some very short lectures, the major portion of the instruction was completed through interactive activites.[7,14,15,16,17,18] The games/activities are crafted to emphasize core creativity competencies and/or steps of a creative problem solving methodology. In addition to the daytime activities, a small design project was assigned as 'homework" that was completed in teams. Students created teams of three or four that collaborated for the week with the stipulation that students from the same institution could not be on the same team.

The instructional portion of each day was approximately eight hours (including breaks and lunch) although often the students were self-motivated to work through breaks and lunch! The days of the week were formatted so that basic skills and tools were developed before moving to subsequent skills that relied upon the previous ones. For example, before creative problem solving can be learned and put to good use, 1) creativity and teamwork must be understood and 2) being creative must be practiced. Therefore the general format of the camp was as follows in Table 1.

Table 1. Format of the camp.

Day	Theme	Activity
1	Creativity	Define creativity and teams, perform team-building exercises, and investigate the core competencies of creativity (Capturing, Challenging, Broadening, Surroundings)[7] through games, projects, and problems.
2	Ingenuity	Overview of the culture of innovation and ingenuity, and American Innovation Tour ("Through the Lens of Innovation" Self-guided Itineraries: Henry Ford Museum, Greenfield Village, Ford F-150 Rouge Factory)
3	Innovation	Innovation 101 (process of innovation, traits of an innovator, keys to innovation, intellectual property rights)
4 and 5	Creative Problem Solving	Investigate six creative problem solving methodologies and their various strategies. Team design projects and presentations.

During the first half day, we discussed what creativity is, who is creative, and broke down any myths about creativity. As will be seen in the Student Perceptions section of this paper, these discussions (and later activities) helped change some preconceptions of the students. The team-building exercises emphasized various functions of teams and also required the students to come into physical contact with one another to break down any barriers and quickly "break the ice." This proved to be very valuable as the camaraderie among the students was conducive to a strong learning environment. In addition during the team-building exercises, various students were asked to take a lead role given unusual constraints/circumstances which illustrated good and bad traits of team leaders.

During the second half of the first day, the four core competencies of creativity were investigated and practiced. (A few other creativity topics were investigated as well such as Bisociation[16,17].) The creativity competencies were derived from Generative Theory research[19,20] and were summarized for classroom instruction by Epstein[7]. They are:

- Capturing – preserving and producing new ideas
- Challenging – seeking challenges and managing them to spur new ideas
- Broadening – exploring new skills, knowledge and training outside your area of expertise
- Surrounding – changing your physical and social environment

Each competency has one or more accompanying in-class activity (i.e., game) that reinforces the skill (Figure 1). The students commented that the games emphasizing and using these competencies were especially worthwhile, not simply because they were fun, but because they reinforced retention. At the end of the day, the students completed a shortened version of the Epstein Creativity Competencies Inventory for Individuals (ECCI-i)[7]. A full, validated test is available[21], but for the purposes of the week, the shortened version allowed each student a general determination of which creativity competencies were strongest and which needed more focus.

Figure 1. A learning activity to emphasize the core competencies of creativity. For further information see Reference 7.

The second day was dedicated to exploring innovative progress and visiting innovative sites as the students toured the Henry Ford Museum, Greenfield Village, and the Ford Rouge Factory where F-150 trucks are assembled. While each of the three sites requires a full day or more to explore, the students used self-guided itineraries focused on innovation and developed by The Henry Ford to allow efficient exploration in the single day format. The itineraries guide students to key attractions and include questions and reflections. The Henry Ford Museum includes areas focused on "Made in America – Manufacturing and Power" which includes some of the earliest Watt steam engines and allows participants to fabricate an actual Model T (Figure 2). Also on display is the ahead-of-its-time 1950s Dymaxion House which featured a quick-build time, post war material construction, and efficient floor plan. The Henry Ford also features automotive, rail, and airplane innovations. Greenfield Village features actual historical buildings from around the world which Henry Ford himself purchased and relocated to Michigan. The students visited the Wright Brothers' bicycle shop where the first airplane was developed and fabricated, Thomas Edison's Menlo Park Complex and Fort Myer Lab, and George Washington Carver's home in addition to many other historical buildings from the past 200+ years (Figure 3). Finally at the Ford Rouge Factory, the students observed modern manufacturing in a plant that serves as a leader in green industrial sustainability.

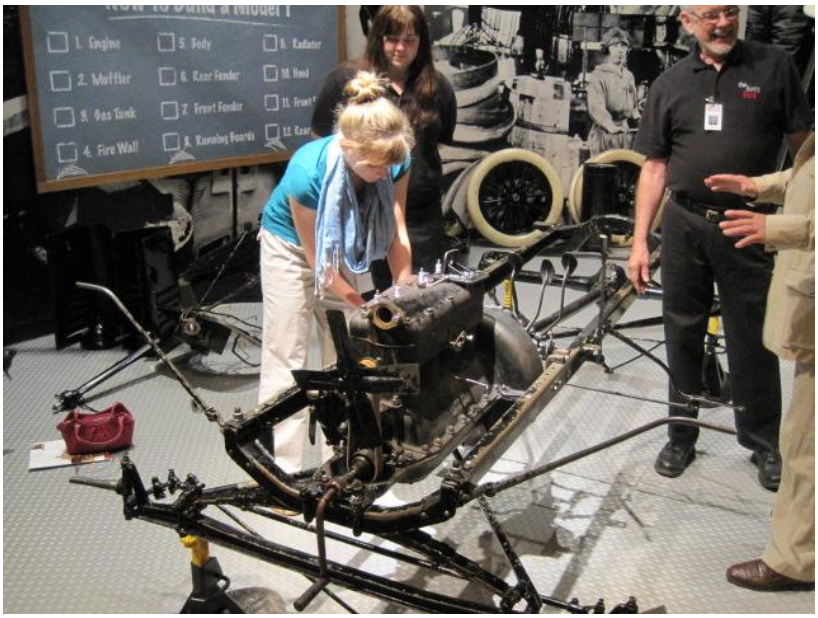

Figure 2. Student fabricating a Model T at the Henry Ford Museum – a hands-on experience of the changes in production over the past 100 years.

Figure 3. Students at Greenfield Village where they were able to encounter the environs of American innovators such as Edison and the Wright brothers.

The third day was held at the Benson Ford Research Center. The Henry Ford has many extensive educational outreach programs, and our camp participants were able to participate in the newly developed Innovation 101 curriculum.[22] The curriculum was originally developed for middle to high school students but was customized for a college-level pilot-offering. Presented in 45 minute interactive learning modules (Figure 4), the students explored innovation and reflected on The Henry Ford-exclusive interviews from innovators such as Steve Wozniak, Pierre Omidyar, Bill Gates, Dean Kamen, and Elon Musk. They compared innovative processes of current-day innovators and analyzed their common traits. Later in the day, the students brought together their observations to identify the keys to innovation such as curiosity, breaking rules, power through collaboration, meeting needs, and embracing risk and lessons from failure. The day was completed with a study of intellectual property rights.

Figure 4. Students participating in Innovation 101 at The Henry Ford.

By the fourth day, the students were prepared to use their foundations of creativity and innovation to solve problems. While many creative problem solving methodologies exist, the instructor found six popular and commonly used methodologies, which vary in the number of steps from four to eight. Upon investigation, all six methodologies have very similar or identical steps; even the sub-steps overlapped. To facilitate learning of the methodologies and allow for more efficient use of classroom time, the methodologies were organized into one "grand" creative problem solving approach that consisted of five steps as follows.

A) Planning your approach
B) Defining the correct problem/understanding the challenge
C) Generate Ideas/Alternatives – Brainstorm
D) Decide course of action/Preparing for action/Carry through/Implement
E) Acceptance and Evaluation

Table 2 shows the general steps of the six methodologies studied and references for each method are given. The letters beside each step correspond to steps A-E listed above. Within each step

are sub-steps that may or may not be needed for a particular problem. Also, there are instances when the problem-solver will return to a previous step and repeat it (more than once perhaps). In fact, each team in the camp typically followed a slightly different methodology from the others to solve problems even though the overall steps were similar.

Table 2. The six creative problem solving methodologies studied.

Question and Answer[23,24]	**CPS**[23,24,25]
A What is wrong? A What do we know? B What is the real problem? C/D What is the best solution? D/E How do we implement the solution?	A Mess Finding A Data Finding B Problem Finding C Idea Finding D Solution Finding E Acceptance Finding
CPS Version 6.1[8]	**Simplex**[23,24,26]
A Planning your approach B Understanding the challenge C Generating Ideas C/D/E Preparing for action	A Problem finding A Fact finding B Problem defining C Idea finding D Evaluating and Selecting D Action planning E Gaining Acceptance D/E Taking Action
Lumsdaine[27,28]	**McMaster 5 point**[14, 15]
A/B Problem definition C Brainstorming C Creative evaluation C/D Judgment D/E Implementation	A/B Define the problem C Generate solutions/alternatives D Decide course of action D Implement solution / carry through E Evaluate solution

During the final two days of the camp, a team project was assigned that encompassed all creative core competencies and all creative problem solving steps. Early on the fourth day, the students watched an ABC News Nightline program titled "Deep Dive."[29] A "think-tank" company, IDEO, was asked by the ABC program's producers to develop a new design for a shopping cart within one week – an extraordinarily tight timeline. In camp, a team assignment was given wherein each student identified the core competencies used by IDEO, the methodology followed by IDEO, and potential problems with the final cart design (likely due to the short timeline). The problems identified by each team were collected, and using the list, a capstone team project was assigned wherein the students had to re-design IDEO's new shopping cart while using the entire creative problem solving method. The students were given 24 hours to complete the design and create a presentation. For the week's finale, each team presented their new shopping cart design to the instructor and other teams (and thoroughly critiqued by all).

In addition to all of the learning activities and The Henry Ford visit, the students were treated to other Detroit-area highlights in the evenings. The students attended a Detroit Tigers baseball game, visited the famous Dream Cruise of Woodward Avenue (a grassroots assemblage/parade of automobiles – historic and muscle cars – which truly showcases the vast car-crazed population of the Motor City), and a Detroit River boat tour.

4. Students' Perceptions and the Influence of the Program

During the first hour of the first day of the camp, the students were asked about their personal view on their own creativity, the role of creativity in engineering, problem solving, teamwork, and leadership. The survey was quantified using a 5-point Likert scale. The same survey was administered after completion of the camp.

With the exception of The Henry Ford site visit, much of the camp content is derived from Lawrence Tech's EGE3351 Creative Problem Solving course which is a one-credit hour regular semester course.[1] As an aside to the assessment of the camp, it is instructive to investigate if a one week experience will achieve similar results as the one semester experience. This may be especially interesting considering that the full semester course allows time for thoughtful reflection (i.e., "soak time"). Therefore, for comparison purposes, data is also presented from Lawrence Tech students that had completed the same pre and post-survey for the semester course. The results were taken from three sections of the course spanning from Fall 2007 to Fall 2011. The Lawrence Tech sample size is 20, and all students were juniors and seniors.

Paired t-tests were conducted on each pair of pre- and post-test statements to determine statistical significance of difference in means. Despite small sample sizes, eight of the fourteen statements have statistically significantly different means between post- and pre-assessment administrations at the 0.1 level (for both the camp participants and the course students).

Perceptions of Creativity

The public does not commonly perceive engineers as creative professionals. A Harris Poll sponsored by the American Association of Engineering Societies and IEEE-USA "found that only 2 percent of the public associate the word 'invents' with engineering; [and] only 3 percent associate the word 'creative' with engineering."[6, 30, 31] It is likely that this image is also in the minds of engineering students, especially underclassmen that have not yet completed significant design and open-ended problem work.

Table 3 indicates the mean response from the 5-point scale of students agreeing with statements concerning creativity before the camp and after the camp. The results for statement 1 indicate an increase in the student perception of being creative either because the camp proved this to them or because the camp improved their creative capacity. There is not a significant change in the response to statement 2, but notice that the students understood that creativity is an important part of engineering before the camp began. Statements 3 shows little shift in perception as is expected from an engineering focused camp. Statement 4 exhibited the largest pre/post change in perception (and a larger change than the course). The cause of this upward shift could be twofold. First, it is possible that the visits to the museum, village, and factory (as well as the innovators' interviews in Innovation 101) opened their eyes to the creativeness of engineers. It is

also speculated that once the students realized that they were creative, then logic would indicate that anyone may be.

	Average (camp)		Standard deviation (camp)		Average (course)		Standard deviation (course)	
	pre	post	pre	post	pre	post	pre	post
1. I am a creative person.	3.86	4.45	0.94	0.51	3.98	4.50	0.77	0.51
2. Creativity is important to the engineering profession.	4.77	4.86	0.43	0.35	4.45	4.65	1.10	0.93
3. Artists (painters, musicians, poets, etc.) are creative people.	4.45	4.52	0.51	0.51	4.05	4.40	0.83	0.68
4. Engineers are creative people.	3.86	4.67	0.99	0.48	3.95	4.45	0.76	0.60

Table 3. Students' mean rating of statements concerning creativity before the camp and after the camp. On a scale of 1 to 5, 1 indicates "strongly disagree" and 5 indicates "strongly agree."

Perceptions of Problem Solving

Table 4 indicates the mean response from the 5-point scale of students agreeing with statements concerning problem solving before the course and after the camp. For statements 5, 6, 7, and 8, it was encouraging to see an upward shift in perception. It appears that the camp has met these goals. The responses to statement 9 decreased as was hoped, and the statistical significance is excellent ($p < 0.03$ for both the camp and $p < 0.04$ for the course). The activities used for the core creativity competency "challenging" and the "Innovations 101 – Keys to Innovation" module appear to have helped the students to realize that solution failure is a necessary part of creating new, better solutions. One student commented that during Innovation 101, one of the most valuable lessons was "*realizing how many failures it may take to succeed.*"

	Average (camp)		Standard deviation (camp)		Average (course)		Standard deviation (course)	
	pre	post	pre	post	pre	post	pre	post
5. I enjoy solving problems.	4.45	4.68	0.60	0.48	3.95	4.45	0.89	0.76
6. I am a good at solving problems.	4.00	4.41	0.53	0.50	3.95	4.35	0.51	0.49
7. When confronting a new problem, I am good at devising many possible solutions.	4.11	4.34	0.65	0.68	3.93	4.10	0.65	0.55
8. When solving a problem, I will try many possible solutions.	3.98	4.26	0.73	0.86	3.50	4.15	0.69	0.81
9. I am discouraged when my solution to a problem fails.	3.18	2.48	0.96	0.98	3.15	2.65	1.14	1.04

Table 4. Students' mean ratings of statements concerning problem solving before the camp and after the camp. On a scale of 1 to 5, 1 indicates "strongly disagree" and 5 indicates "strongly agree."

Perceptions of Teamwork and Leadership

Table 5 indicates the mean response from the 5-point scale of students agreeing with statements concerning teamwork and leadership before the camp and after the camp. For statement 10, the mean drops slightly for the camp participants while it increases significantly for the course students. The pairwise t-test indicates that the camp results are statistically insignificant, while

the course results are extremely statistically significant ($p < 0.0009$). Nonetheless, the result is of no surprise. A main objective for the course is development of leadership skills, and there are multiple opportunities to practice and critique others' leadership skills. Due to time constraints, leadership development was not a focus of the camp curriculum, nor did it need to be based on their pre-camp average. (It is likely many of the camp students were specially selected by their home institution to participate based on their leadership ability which in turn allows the students to facilitate many of the week's activities for peers back home; more on that in section 7.) The students showed an upward shift in the importance to work in teams for problem solving and an increased preference to work in teams (with an accompanying downward shift in the reference to work alone). For statement 13, the students found through the camp emphasis on teamwork, that one individual will not solve a problem (or develop a product) as effectively as will many minds working toward a common goal.

	Average (camp)		Standard deviation (camp)		Average (course)		Standard deviation (course)	
	pre	post	pre	post	pre	post	pre	post
10. I am an effective team leader.	4.36	4.27	0.58	0.55	3.68	4.20	0.61	0.62
11. It is important for engineers to be effective leaders.	4.36	4.55	0.66	0.51	4.32	4.65	0.82	0.59
12. It is important to work in a team to solve problems.	4.18	4.76	0.91	0.44	3.77	4.25	1.01	0.91
13. I prefer to work alone when solving a problem.	2.43	2.19	0.88	1.08	2.70	2.38	1.03	0.58
14. I prefer to work with others when solving a problem.	3.95	4.43	0.84	0.60	3.43	3.73	0.78	0.72

Table 5. Students' ratings of statements concerning teamwork and leadership before the camp and after the camp. On a scale of 1 to 5, 1 indicates "strongly disagree" and 5 indicates "strongly agree."

Overall Perceptions

In general, the gains in average responses from the camp were similar to those from the semester-long course (with the exception of leadership). Questions 4 and 9 for the camp students actually realized better pre to post changes than the course, perhaps due to the added feature of The Henry Ford. Figure 5 presents average camp student responses to each statement in a bar graph. This information was presented earlier in the paper, but is given in bar graph format to visualize the overall responses and changes from pre-camp to post-camp. Overall, while most differences are statistically significant, are they evidence of meaningful changes in attitude, especially considering that the pre to post differences appear small, and the students were already interested in the subject-matter? One could argue that the students' interest in the subject-matter and prior education in entrepreneurial programs are exactly what makes the pre to post differences meaningful. One would assume that the students would give high ratings for the statements before the camp (and in fact they did), which would make any shift in perception difficult or even unlikely. The fact that the ratings did increase with less than one week of activities may indicate meaningful change. Further studies would have to be performed to verify the theory.

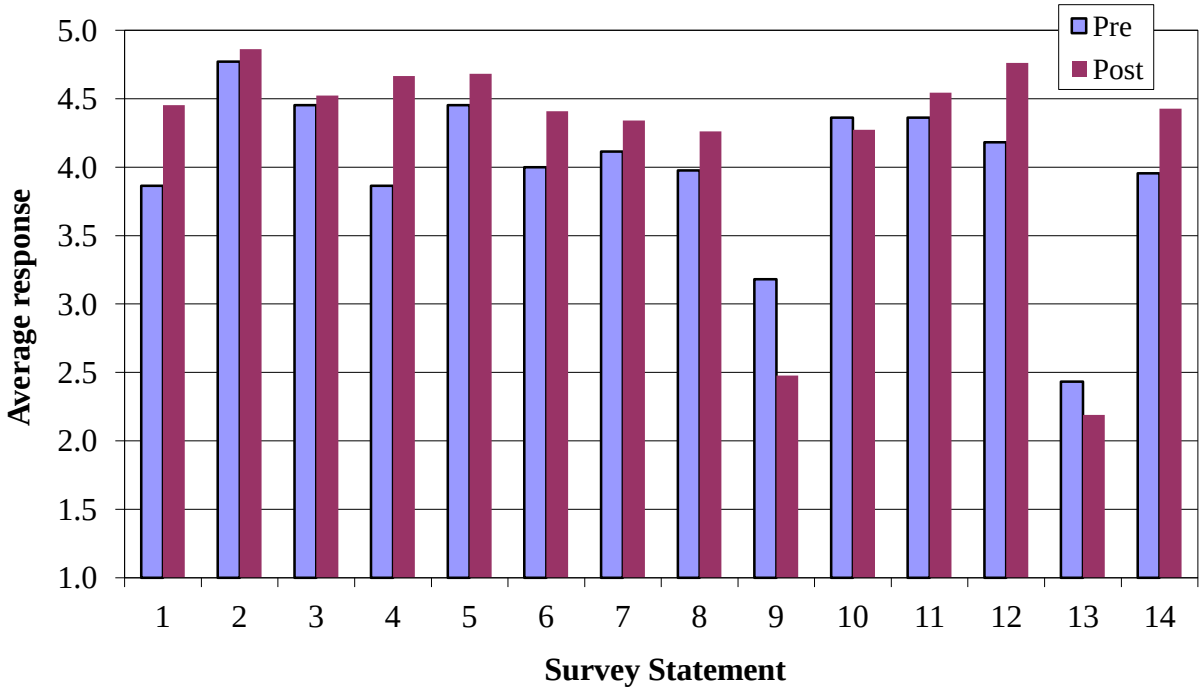

Figure 5. Students' ratings of statements concerning creativity, problem-solving, teamwork, and leadership before the camp and after the camp. On a scale of 1 to 5, 1 indicates "strongly disagree" and 5 indicates "strongly agree."

5. Students' Opinion of the Camp

Three weeks after the camp concluded, the students were surveyed on their opinion of the enrichment program. Seventeen of the 23 students responded. Table 6 shows the results of student perceptions concerning their overall perception of the camp. The averages are very good, especially considering that this is the first time facilitating a Lawrence Tech/Henry Ford collaboration for a multi-institutional camp.

	Average	Standard deviation
How would you rate your experience for the three instructional days at LTU?	4.71	0.47
How would you rate your experience for the two instructional days at The Henry Ford?	4.29	0.69
This workshop helped me understand the entrepreneurial mindset.	4.47	0.51
Overall, the week met my expectations.	4.65	0.49
Having more than one instructor and location of instruction (i.e., The Henry Ford and Lawrence Tech) was beneficial.	4.53	0.51

Table 6. Student ratings of statements about the summer enrichment program. For the first two statements, on a scale of 1 to 5, 1 indicates "unsatisfactory" and 5 indicates "excellent." For the third through fifth statements, on a scale of 1 to 5, 1 indicates "strongly disagree" and 5 indicates "strongly agree."

When the students were asked (anonymously, of course) if they would recommend this workshop to other students at their university, 100% of the students responded "yes."

Lawrence Tech Instruction Survey Results

Table 7 shows the results concerning the length and amount of instruction for days 1, 4, and 5 at Lawrence Tech. Eight hours of instruction for multiple days can be daunting/exhausting, and yet on average, the students considered the extent "just right." Much of this may be attributed to the active learning and teamwork. The "fun factor" certainly helps keep student motivation.

	Average	Standard deviation
The length of the instructional part of each day was:	3.23	0.44
The amount of activities/instruction was:	3.05	0.43

Table 7. Student ratings of statements concerning the extent of instruction/activities at Lawrence Tech (i.e., days 1, 4, 5). On a scale of 1 to 5, 1 indicates "too short/too little," 3 indicates "just right," and 5 indicates "too long/too much."

To ensure that poor instruction was not a factor to student perceptions presented in this paper, the students rated statements concerning the Lawrence Tech instructor on a scale of 1 to 5, where 1 indicates "strongly disagree/unsatisfactory" and 5 indicates "strongly agree/excellent." Table 8 indicates the instructor performed very well.

	Average	Standard deviation
The instructor's presentations/materials/activities were well prepared.	4.76	0.44
I felt comfortable asking the instructor questions.	4.82	0.39
The instructor was willing and able to answer questions.	4.88	0.33
How would you rate the instructor's overall performance?	4.94	0.24

Table 8. Student ratings of statements concerning the camp instructor at Lawrence Tech (i.e., days 1, 4, 5). On a scale of 1 to 5, 1 indicates "strongly disagree/unsatisfactory" and 5 indicates "strongly agree/excellent."

The Henry Ford Instruction Survey Results

Table 9 shows the results concerning the length and amount of instruction for days 2 and 3 at The Henry Ford (although day 2 was not so much formal instruction as it was self-guided learning tours). The average for length indicates that it was slightly long. The most likely reason is the overwhelming amount of sightseeing on day 2, leading to fatigue by day's end. At least six students commented that the touring/sight-seeing on day 2 and the classroom workshop on day 3 should be split and mixed, with some of each on both days. The amount of activities was "just right."

	Average	Standard deviation
The length of the instructional part of each day was:	3.76	0.90
The amount of activities/instruction was:	2.94	0.97

Table 9. Student ratings of statements concerning the breadth of instruction/activities at The Henry Ford (i.e., days 2, 3). On a scale of 1 to 5, 1 indicates "too short/too little," 3 indicates "just right," and 5 indicates "too long/too much."

Again, to ensure that poor instruction was not a factor to student perceptions presented in this paper, the students rated statements concerning The Henry Ford instructor/facilitator on a scale of 1 to 5, where 1 indicates "strongly disagree/unsatisfactory" and 5 indicates "strongly agree/excellent." It is worth noting that this was the first time that Innovation 101 was administered to college students, as well as the first time that the curriculum was modified for a single day workshop. With that stated, Table 10 indicates the instructor performed especially well.

	Average	Standard deviation
The instructor's presentations/materials/activities were well prepared.	4.17	0.88
I felt comfortable asking the instructor questions.	3.94	1.02
The instructor was willing and able to answer questions.	4.47	0.51
How would you rate the instructor's overall performance?	4.11	0.93

Table 10. Student ratings of statements concerning the camp instructor at The Henry Ford (i.e., days 2, 3). On a scale of 1 to 5, 1 indicates "strongly disagree/unsatisfactory" and 5 indicates "strongly agree/excellent."

6. Student Comments Regarding the Camp

The students were asked to comment on what they liked about the days spent at Lawrence Tech (with a focus on creativity and creative problem solving). Twelve of the 15 comments pertain to liking the games, activities, and project (no surprise there). One student commented, "*My mind was opened to the multitude of possibilities of innovative thinking.*" Another student commented, "*I loved how [the instructor] helped us challenge our traditional views and got us thinking more creatively.*" One more student stated, "*The intimate size of the group, the mix of students, the instructor...could not have asked for better. I want to do it again!*"

Next the students were asked what should be changed for the days spent at Lawrence Tech. Of the 14 students who left a comment, seven of them stated/implied that nothing should be changed. Two of the students wanted more days, and another student stated, "*I want to do it again!*". Since the classroom games were mostly to reinforce the core creativity competencies, the games were grouped at the beginning of the week. Therefore, three students implied that the games/activities should be more spread out and interspersed with the lectures during the fourth and fifth days. Unfortunately, the core competencies should be learned before the creative problem solving, and there are not many games for the second-half material; creative problem

solving caters better to short team assignments. Consequently, the games cannot effectively be interspersed throughout the week.

The students were asked to comment on what they liked about the days spent at The Henry Ford (with a focus on innovation and American manufacturing). Perhaps the most poignant commented is, "*Visiting the Rouge, Greenfield Village and the HF Museum were incredible experiences that changed my life outlook in the most positive way.*" Five of the 15 comments expressed a fondness for the Innovation 101 curriculum, while 14 of the 15 most liked one or all of the tour sites. In particular one student stated that he liked "*the creative inspiration I received behind the exhibits and presentations. They worked very well together to spark my interest in inventing and creativity.*" One student that most enjoyed the Ford Factory tour commented, "*As an engineer, the factory was astounding to look at and experience and incredibly innovative.*" Another student stated, "*It showed innovation in the works, especially since it is a lean factory, which focuses on continuous improvement.*" A student commented that the most valuable part of the days spent at The Henry Ford was "*the introduction to innovation [which] was reinforced by the tours and discussions*." A student that found Innovation 101 most valuable commented, "*The lesson was valuable because it gives us an advantage to be a successful innovator and dig deep in our aspirations.*"

Finally, the students were asked what should be changed for the days spent at The Henry Ford. Three students commented that the Innovation 101 curriculum needed to be more advanced, while another simply called it "*boring.*" As mentioned above, this was the first time that The Henry Ford had attempted a conversion of the curriculum for college students. Three other students implied that more time was needed for the tour sites, which is no surprise.

In general (either for the Lawrence Tech portion or Henry Ford portion), two students wanted more information on patents: "*The program should have some more focus on Patents*," and "*…more help with what to do once you have a good idea (patents, who to contact, etc.).*" Due to time constraints, patenting was not considered for inclusion in the camp, but perhaps for future offerings, consideration can be given to altering content.

7. Benefits of a Multi-Institutional Collaboration

Student Benefits

One of the obvious benefits of the multi-institutional collaboration is the opportunity for the students to visit a new region of the country. This was made clear when a student noted, "*If I had never participated in this program, I most likely would have never had the opportunity to visit the museum and Ford plant.*" Also the students were able to meet peers and make new connections. When asked if the students have stayed or would stay in contact with the students from other universities that they met during the week, 14 of 17 responded "yes," while the remaining 3 responded "maybe." The students became so close that they were planning reunions even before they returned to the Detroit airport and had already established social networking connections. Finally, the students were able to experience multiple educational perspectives from both their peers and the "unfamiliar" host university (i.e., each university offers different resources). In particular, a student noted, "Having all of us work as groups from different

schools made it so that we were able to solve the problems given to us using the skills taught at all of the different schools."

Benefits to the Partner Institutions

Because of the partnership among the universities, they can collaborate on any portion of the curricula that is lacking in entrepreneurship education and form a plan to enrich their students' education. In this particular instance, creativity and innovation is not a focused topic in the respective college curricula. While the topic does emerge within a course here and there, it is not elaborated upon in the detail in which the enrichment program can offer. In addition, the educational material for the camp (activities, lectures, etc.) did not all emerge from the host institution of Lawrence Tech. Many of the ideas came from other schools within KEEN. Through the years of KEEN workshops, conference, seminars, and general networking, an abundance of learning tools and topics is accumulated. Another benefit is financial. Sharing the costs makes the "free-of-charge" camp affordable for the host institution who can service 20+ students. Finally, one of the largest benefits comes from the students themselves. After a successful camp, the students return to their home institution inspired and want to share their newfound knowledge and experience with their classmates. Before embarking for the camp, the students from St. Louis University (SLU) were asked to bring back what they could to teach others. The result, two months later, was a successful workshop facilitated by the camp students for 80 of their peers at SLU. In other words, the learning does not stop with the camp participants; it expanded well beyond the borders of the host institution. Similar interactions were experienced by the other institutions who participated.

8. Conclusion

A summer enrichment program was successfully developed and facilitated for a multi-institutional collaboration. The program expanded the students' understanding of the entrepreneurial mindset and broadened their skills in creativity and innovation. Assessment results indicate that their perceptions of creativity, teamwork, problem solving/design, risk taking, and learning through failure improved. The interactive, team-focused format of the camp encouraged excitement toward key entrepreneurial skills. Finally, the multi-institutional collaboration allowed for a multitude of benefits that could not be realized through a single institution's effort. The model presented herein could be replicated by other institutional collaborations with regional themes and hopefully validated by the camps planned in the next two years in Boston and St. Louis which will based around different themes and competencies (but still related to elements of the entrepreneurial mindset).

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