An Effective Assignment for Teaching Creative Problem Solving for Online and Face-to-Face Classes

R. Ocon
Purdue University Northwest, Hammond, United States

***Abstract*—In today's competitive work environment, the need for engineering and technology students to develop creative problem solving skills cannot be overstated. Creative thinking is required to solve the many complex and unstructured problems encountered in the workplace. Therefore, it is imperative that faculty develop assignments that can promote creative problem solving and be used with different modes of course delivery. One creative problem solving assignment the author developed for both his online and face-to-face courses, was an assignment where students were required to build a physical model on a given problem and solution.**

In the paper, the author described the major components of the Creative Problem Solving Assignment. The paper identified the benefits derived from using the assignment to develop creative thinking skills. In the paper, the author assessed the assignment on promoting creative problem solving skills. Also, the author provided ideas for engineering and technology faculty on how to develop assignments for both online and face-to-face course delivery. Finally, the author compared the evaluation results of the assignment between his online and face-to-face classes.

***Index Terms*—Brief, Creative Problem Solving Assignment (CPS Assignment), physical model, course delivery.**

Introduction

In the 2015 movie, "The Martian," the main character (actor Matt Damon), stranded on the planet Mars, spoke about how problem solving enabled him to survive and get rescued [1]. In the movie, the actor stated, "you begin by solving one problem, then the next problem and if you solve enough problems you get to go home." For movie-goers, The Martian movie helped to illustrate the importance of problem solving. However, for most people in general, the importance of problem solving goes beyond outer space. For people to be successful in their careers, relationships and lives, they must be effective problem solvers [2]. For students to achieve both personal and career success, they need to develop their problem solving skills. Unfortunately, our educational system is not providing students with the required training for developing their imaginations and problem solving skills to generate creative ideas to solve complex problems [3].

I. COMPONENTS OF THE CREATIVE PROBLEM SOLVING ASSIGNMENT

Recognizing the importance of problems solving, the author has endeavored to educate students on how to develop their creative problem solving skills. Over the years, he has experimented with various course assignments to promote the use of imagination and creativity. One major course assignment the author created, the subject of this paper, was the CPS Assignment which was designed to promote student imagination in solving either a personal or work related problem.

The Creative Problem Solving Assignment provided students with the opportunity to apply the components of the Creative Problem Solving Process, which the author tuaght throughout the semester [4], [5], [6]. In a nutshell, the Assignment required each student to identify a personal or work related problem and construct a physical model that represented the problem and its creative solution. Specifically, the Assignment was composed of 3 sub-assignments or components.

(1) First, students were required to develop a Brief, which is a general outline of the problem and process for solving the problem. Table I provides a summary of the requirements for the Brief.

TABLE I.
THE 9 COMPONENTS OF THE BRIEF [3], [6], [7]

- A creative title for the assignment/problem.
- Background information on the problem.
- The "Problem Statement" (state the problem as a set of facts).
- The "Creative Challenge" (state the problem as a question).
- The best creative solution to the problem.
- The alternative (second best solution) solution to the problem.
- A written description of the physical model representing the problem and solution.
- The main idea generation technique(s) used to stimulate the imagination for solving the problem.
- A sketch of the physical model.

(2) Second, students were required to use visualization and create a Physical Model (made primarily of Popsicle

Sticks) representing the problem and solution to that problem. The requirements for the Model:

1. 70%-100% of the Model had to be composed of 4 or 6 inch Popsicle Sticks.

2. 0%-30% of the Model could be composed of other materials, such as:

- Arts & Craft Material (LEGOS).
- Machine parts or tools.
- Rocks, wood and other objects from nature.
- Cardboard, wooden blocks, clay, etc.

The purpose of the Model was to provide students with the opportunity to use their imaginations to visualize a problem in such detail that they could build a physical model representing the problem and solution [4], [8], [9].

(3) Third, students were required to develop a PowerPoint Presentation on the Assignment [8].

II. PREPARATION FOR THE CPS ASSIGNMENT

During the first 8-10 weeks of the semester, students learned about visualization, mental barriers to creativity and the phases of the Creative Problem Solving Process [4], [5], [6], [7]. The CPS Assignment provided an opportunity for students to apply what was learned during the first 8-10 weeks of the semester by developing a Brief, Physical Model and PowerPoint Presentation (the 3 sub-assignments or components of the CPS Assignment).

After developing the Brief, Model and Presentation, each student was required to evaluate and provide feedback on the CPS Assignment and the 3 sub-assignments. Tables III-XI provide a summary of student responses to selected questions related to the CPS Assignment and 3 sub-assignments.

III. BENEFITS OF USING THE CPS ASSIGNMENT TO TEACH CREATIVE PROBLEM SOLVING SKILLS

The CPS Assignment involved whole brain thinking, where students were able to integrate both left brain and right brain thinking. Generally speaking, assignments that involve whole brain thinking provide students with the opportunity to expand and focus their thinking, think logically & imaginatively, and lets them see relationships between different aspects of a problem [4].

The author noted that the CPS Assignment, where students had the opportunity to use their imaginations and creative problem solving skills, created excitement and inspired student interest and learning. Also, using student personal problems raised the level and quality of student participation in the course [10], [11]. By integrating problem solving assignments into a course, including personal problems, an instructor can effectively promote a positive learning environment.

Based on the assessment results (Tables III-XI), the author identified the benefits associated with the Assignment. Table II lists the major benefits derived from the CPS Assignment.

TABLE II.
MAJOR BENEFITS DERIVED FROM THE CPS ASSIGNMENT

- Encouraged students to play with ideas and concepts.
- Promoted the concept that creativity is a process that can be learned and developed.
- Identified the advantages associated with different idea generation techniques.
- Promoted the use of incubation when problem solving.
- Can be used to illustrate creative problem solving and other course-related concepts.
- Provided insight and perspective for understanding problems.
- Promoted the use of intuition when problem solving.
- Encouraged the search for multiple solutions for problems.
- Highlighted the importance of building a physical model to promote creative problem solving.
- Promoted the use of sketching when problem solving.
- Can be used with most engineering/technology courses.
- Provided an opportunity for students to interact or collaborate with classmates or non-students (friends/family) while generating and developing ideas for the model
- Promoted the use of visualization when problem solving.
- Created a positive, fun and interesting class environment that promoted student participation.
- Provided students with the opportunity to use and develop their communication skills.
- Stimulated the imaginations of students.

IV. ASSESSMENT OF THE CREATIVE PROBLEM SOLVING ASSIGNMENT

The author took a comprehensive approach to evaluating the Creative Problem Solving Assignment by using a variety of assessments [9]. The overall conclusion from student responses to selective questions was that the Assignment was an effective teaching method for promoting creative problem solving skills in online and face-to-face courses. The results from student responses on the various aspects of the Assignment are listed in Tables III-XI, along with a summary of those tables.

Table III provides a summary and comparison of student responses to selected questions related to promoting creative problem solving skills from the online class Pretest and Posttest.

TABLE III.
SUMMARY OF STUDENT RESPONSES TO SELECTED QUESTIONS FROM THE ONLINE PRETEST AND POSTTEST RELATED TO CPS

Class XXXXXX (Fall 2017)	Pretest (Online Class)	Posttest (Online Class)
T: True, F: False, I: Don't know	Average Score (Correct Answers)	Average Score (Correct Answers)
1. Most people remember what they see better than what they hear.	91%	100%
2. Humor and play should be avoided when we are generating ideas to help solve problems.	64%	85%
3. It is easier to turn wild or unusual ideas into practical solution than to turn routine ideas into innovative solutions.	55%	80%
4. Creativity is a personal characteristic that only a select few possess.	91%	90%
5. I frequently sketch a problem that I am trying to solve.	59%	80%
6. Creativity is a process involving a sequence of several steps or phases.	86%	100%
7. I understand a problem better if I can see and examine/touch it, instead of just thinking about it.	91%	90%
8. I am familiar with the benefits associated with different idea generation techniques.	68%	85%
9. Generating creative ideas for problem solving is relatively easy for me.	64%	85%
10. I frequently use imagination when I'm engaged in creative problem solving.	91%	100%
11. Incubation is an effective way to understand and/or develop ideas.	45%	79%
12. I frequently use visualization to help understand and solve problems.	91%	100%
13. I am familiar with at least 3 idea generation techniques.	45%	100%
14. When solving problems or making decisions we should avoid using intuition.	64%	79%
15. When I find a solution to a problem, I usually continue looking for additional solutions for that problem.	63%	84%
Number of Students	22	20

A. Summary: Online Class Pretest and Posttest

A comparison of the Pretest and Posttest results for the online class showed that out of 15 selected questions, the Posttest had an improvement in scores on 13 questions. The two questions that did not score higher on the Posttest were Questions 4 and 7 (both Questions 4 and 7 had Pretest scores of 91% and Posttest scores of 90%). Based on the Pretest and Posttest results, the author concluded that students in the online class, for the most part, learned the relevant creative problem solving concepts.

Table IV provides a summary and comparison of student responses to selected questions related to promoting creative problem solving skills from the face-to-face class Pretest and Posttest.

TABLE IV.
SUMMARY OF STUDENT RESPONSES TO SELECTED QUESTIONS FROM THE FACE-TO-FACE PRETEST AND POSTTEST RELATED TO CPS

Class XXXXXX (Fall 2017)	Pretest (Face-to-Face Class)	Posttest (Face-to-Face Class)
T: True, F: False, I: Don't know	Average Score (Correct Answers)	Average Score (Correct Answers)
1. Most people remember what they see better than what they hear.	92%	92%
2. Humor and play should be avoided when we are generating ideas to help solve problems.	80%	83%
3. It is easier to turn wild or unusual ideas into practical solution than to turn routine ideas into innovative solutions.	64%	83%
4. Creativity is a personal characteristic that only a select few possess.	92%	83%
5. I frequently sketch a problem that I am trying to solve.	60%	75%
6. Creativity is a process involving a sequence of several steps or phases.	56%	71%
7. I understand a problem better if I can see and examine/touch it, instead of just thinking about it.	88%	71%
8. I am familiar with the benefits associated with different idea generation techniques.	72%	96%
9. Generating creative ideas for problem solving is relatively easy for me.	52%	88%
10. I frequently use imagination when I'm engaged in creative problem solving.	84%	88%
11. Incubation is an effective way to understand and/or develop ideas.	84%	83%

12. I frequently use visualization to help understand and solve problems.	76%	96%
13. I am familiar with at least 3 idea generation techniques.	40%	96%
14. When solving problems or making decisions we should avoid using intuition.	76%	71%
15. When I find a solution to a problem, I usually continue looking for additional solutions for that problem.	80%	92%
Number of Students	25	24

B. Summary: Face-to-Face Class Pretest and Posttest

A comparison of the Pretest and Posttest results for the face-to-face class showed that out of 15 selected questions, the Posttest had an improvement in scores on 10 questions. Two questions that did not score higher on the Posttest were Questions 1 and 11 (Question 1 had a Pretest and Posttest score of 92% and Question 11 had a Pretest score of 84% and Posttest score of 83%). Based on the Pretest and Posttest results, the author concluded that students in the face-to-face class, for the most part, learned the relevant creative problem solving concepts.

Table V provides a summary and comparison of student responses to selected questions related to promoting creative problem solving skills from the online and face-to-face classes on the Posttest.

TABLE V.
SUMMARY OF STUDENT RESPONSES TO SELECTED QUESTIONS FROM THE ONLINE AND FACE-TO-FACE POSTTEST RELATED TO CPS

Class XXXXXX (Fall 2017)	Posttest (Online Class)	Posttest (Face-to-Face Class)
T: True, F: False, I: Don't know	Average Score (Correct Answer)	Average Score (Correct Answer)
1. Most people remember what they see better than what they hear.	100%	92%
2. Humor and play should be avoided when we are generating ideas to help solve problems.	85%	83%
3. It is easier to turn wild or unusual ideas into practical solution than to turn routine ideas into innovative solutions.	80%	83%
4. Creativity is a personal characteristic that only a select few possess.	90%	83%
5. I frequently sketch a problem that I am trying to solve.	80%	75%
6. Creativity is a process involving a sequence of several steps or phases.	100%	71%
7. I understand a problem better if I can see and examine/touch it, instead of just thinking about it.	90%	71%
8. I am familiar with the benefits associated with different idea generation techniques.	85%	96%
9. Generating creative ideas for problem solving is relatively easy for me.	85%	88%
10. I frequently use imagination when I'm engaged in creative problem solving.	100%	88%
11. Incubation is an effective way to understand and/or develop ideas.	79%	83%
12. I frequently use visualization to help understand and solve problems.	100%	96%
13. I am familiar with at least 3 idea generation techniques.	100%	96%
14. When solving problems or making decisions we should avoid using intuition.	79%	71%
15. When I find a solution to a problem, I usually continue looking for additional solutions for that problem.	84%	92%
Number of Students	20	24

C. Summary: Compare Online and Face-to-Face Classes Posttest

A comparison of student responses from the Posttest for the online and face-to-face classes to selected questions showed that the online class results exceeded the face-to-face class results in 10 out of 15 questions. However, for 5 questions where the online class scored higher than the face-to-face class (Questions 2, 3, 9, 12, and 13), the difference in scores between the two classes was minimal. For the most part, the difference in Posttest scores for the online and face-to-face classes was insignificant. Based on the results of the Posttest, the author concluded that the students in both the online and face-to-face classes learned the relevant creative problem solving concepts.

D. Two Assessments of the Brief

Recognizing the importance of the Brief in creative problem solving, the author used two assessment tools (with different questions) to evaluate the effectiveness of the Brief. One evaluation focused on assessing the different components of the Brief as they related to promoting creative problem solving skills and the second evaluation compared the Brief with the Model and Presentation concerning its effectiveness for promoting creative problem solving skills.

Table VI provides a summary and comparison of student responses to selected questions related to promoting creative problem solving skills and the

effectiveness of the components of the Brief for the online and face-to-face classes.

TABLE VI.
EVALUATION ON HOW IMPORTANT EACH COMPONENT OF THE BRIEF WAS IN PROMOTING CREATIVE PROBLEM SOLVING FOR THE ONLINE AND FACE-TO-FACE CLASSES

Class XXXXXX (Fall 2017)	Brief	Brief
Scale: 1. Strongly Disagree, 2. Disagree. 3. Neither Agree/Disagree, 4. Agree, 5. Strongly Agree	Average Score (Online Class)	Average Score (Face-to-Face Class)
1. A creative title for the project or problem- is important in promoting creative problem solving.	4.0	4.26
2. Background information on the project/problem- is important in promoting creative problem solving.	4.6	4.65
3. The "Problem as Stated"- is important in promoting creative problem solving.	3.75	4.18
4. The "Problem as Understand"- is important in promoting creative problem solving.	4.15	4.43
5. The creative solution (best solution) to the problem- is important in promoting creative problem solving.	4.75	4.52
6. The alternative (2nd best) solution to the problem- is important in promoting creative problem solving.	3.90	4.0
7. The written description of the 3-D physical model the students created using Popsicle Sticks- is important in promoting creative problem solving.	4.25	4.09
8. Identifying the main idea generation technique(s) used to stimulate your imagination for the Project solution/creative problem solving- is important in promoting creative problem solving.	3.72	3.70
9. A sketch of the 3-D model- is important in promoting creative problem solving.	4.25	3.91
Number of Students.	20	23

E. Summary:Online & Face-to-Face Classes Evaluations of the Brief Components

Table VI showed that out of 9 selected questions on the components of the Brief, the face-to-face class scores exceeded those of the online class in 5 out of 9 questions. However, the difference in scores between the two classes was insignificant. Based on the student responses to the Brief's evaluation of its components, the author concluded that the Brief assignment was effective in promoting both the CPS Assignment and creative problem solving skills for both the online and face-to-face classes.

Table VII provides a summary and comparison of student responses to selected questions related to promoting creative problem solving skills for the online and face-to-face classes on the Brief.

TABLE VII.
EVALUATION ON THE EFFECTIVENESS OF THE BRIEF IN PROMOTING CREATIVE PROBLEM SOLVING FOR THE ONLINE AND FACE-TO-FACE CLASSES

Class XXXXXX (Fall 2017)	Brief	Brief
Scale: 1. Strongly Disagree, 2. Disagree. 3. Neither Agree/Disagree, 4. Agree, 5. Strongly Agree	Average Score (Online Class)	Average Score (Face-to-Face Class)
1. Allowed me to use humor and play when generating ideas or solutions for the project problem.	4.24	4.42
2. Allowed me to express my creativity.	4.68	4.60
3. Allowed me to use the sketch to better understand that problem and/or generate ideas/solutions for the project problem.	4.33	4.27
4. Allowed me to use the steps or phases in the CPSP.	4.38	4.54
5. Seeing and/or physically examining the project problem, allowed me to better understand the problem and generate ideas/solutions.	4.24	4.58
6. Allowed me to recognize the benefits associated with different idea generation techniques.	4.52	4.65
7. Made it relatively easy for me to generate creative ideas or solutions for the project problem.	4.33	4.58
8. Allowed me to use my imagination when generating ideas or solutions for the project problem.	4.81	4.58
9. Allowed me to use incubation to understand the problem and/or generate ideas/solutions for the project problem.	4.38	4.46
10. Allowed me to use visualization to help me to better understand the problem and/or generate ideas/solutions for the project problem.	4.38	4.58
11. Allowed me to become familiar with different idea generation techniques.	4.57	4.54
12. Allowed me to use intuition when generating ideas/solutions	4.38	4.58

for the problem project.		
13. Allowed me to look for additional solutions for the project problem.	4.29	4.73
Number of Students.	21	26

F. Summary:Online & Face-to-Face Classes Evaluations of the Brief

Comparing student responses on evaluating the Brief showed the face-to-face class scores exceeded those of the online class in 10 out of 13 questions. However, for 3 questions where the face-to-face class scored higher than the online class (Questions 1, 3 and 11) the difference in scores between the two classes was insignificant. Overall, both the online and face-to-face classes scored well on the 13 selected questions. Based on the student responses to the Brief evaluations, the author concluded that the Brief assignment was effective in promoting creative problem solving skills for both the online and face-to-face classes.

Table VIII provides a summary and comparison of student responses to selected questions related to promoting creative problem solving skills from the Physical Model for the online and face-to-face classes.

TABLE VIII.
EVALUATION ON THE EFFECTIVENESS OF THE PHYSICAL MODEL ASSIGNMENT IN PROMOTING CREATIVE PROBLEM SOLVING FOR THE ONLINE AND FACE-TO-FACE CLASSES

Class XXXXXX (Fall 2017)	Model	Model
Scale: 1. Strongly Disagree, 2. Disagree. 3. Neither Agree/Disagree, 4. Agree, 5. Strongly Agree	Average Score (Online Class)	Average Score (Face-to-Face Class)
1. Allowed me to use humor and play when generating ideas or solutions for the project problem.	4.24	4.69
2. Allowed me to express my creativity.	4.67	4.96
3. Allowed me to use the sketch to better understand that problem and/or generate ideas/solutions for the project problem.	4.29	4.69
4. Allowed me to use the steps or phases in the CPSP.	4.38	4.58
5. Seeing and/or physically examining the project problem, allowed me to better understand the problem and generate ideas/solutions.	4.24	4.58
6. Allowed me to recognize the benefits associated with different idea generation techniques.	4.38	4.62
7. Made it relatively easy for me to generate creative ideas or solutions for the project problem.	4.33	4.58
8. Allowed me to use my imagination when generating ideas or solutions for the project problem.	4.48	4.77
9. Allowed me to use incubation to understand the problem and/or generate ideas/solutions for the project problem.	4.24	4.73
10. Allowed me to use visualization to help me to better understand the problem and/or generate ideas/solutions for the project problem.	4.57	4.77
11. Allowed me to become familiar with different idea generation techniques.	4.48	4.62
12. Allowed me to use intuition when generating ideas/solutions for the problem project.	410	4.65
13. Allowed me to look for additional solutions for the project problem.	4.29	4.62
Number of Students	21	26

G. Summary:Online & Face-to-Face Classes Evaluations of the Physical Model

Comparing student responses on evaluating the Model, the face-to-face class scored higher than the online class on all 15 questions related to promoting creative problem solving skills. However, the difference in scores between the two classes was insignificant. Overall, both the online and face-to-face classes scored well on the 13 selected questions. Based on the student responses to the Model evaluation, the author concluded that the Model assignment was effective in promoting creative problem solving skills for both the online and face-to-face classes.

Table IX provides a summary and comparison of student responses to selected questions related to promoting creative problem solving skills from the PowerPoint Presentation for the online and face-to-face classes.

TABLE IX.
EVALUATION ON THE EFFECTIVENESS OF THE PRESENTATION ASSIGNMENT IN PROMOTING CREATIVE PROBLEM SOLVING FOR THE ONLINE AND FACE-TO-FACE CLASSES

Class XXXXXX (Fall 2017)	Presentation	Presentation
Scale: 1. Strongly Disagree, 2. Disagree. 3. Neither Agree/Disagree, 4. Agree, 5. Strongly Agree	Average Score (Online Class)	Average Score (Face-to-Face Class)
1. Allowed me to use humor and play when generating ideas or solutions for the project problem.	4.0	4.54
2. Allowed me to express my creativity.	4.38	4.76
3. Allowed me to use the sketch to better understand	4.0	4.27

that problem and/or generate ideas/solutions for the project problem.		
4. Allowed me to use the steps or phases in the CPSP.	3.86	4.46
5. Seeing and/or physically examining the project problem, allowed me to better understand the problem and generate ideas/solutions.	3.76	4.50
6. Allowed me to recognize the benefits associated with different idea generation techniques.	4.05	4.46
7. Made it relatively easy for me to generate creative ideas or solutions for the project problem.	4.14	4.46
8. Allowed me to use my imagination when generating ideas or solutions for the project problem.	4.14	4.69
9. Allowed me to use incubation to understand the problem and/or generate ideas/solutions for the project problem.	4.05	4.62
10. Allowed the use of visualization to help me to better understand the problem and/or generate ideas/solutions for the project problem.	4.05	4.65
11. Allowed me to become familiar with different idea generation techniques.	4.14	4.58
12. Allowed me to use intuition when generating ideas/solutions for the project problem.	3.95	4.62
13. Allowed me to look for additional solutions for the project problem.	3.86	4.65
Number of Students.	21	26

H. Summary:Online & Face-to-Face Classes Evaluations of the Presentation

Comparing student responses on evaluating the PowerPoint Presentation, the face-to-face class scored higher than the online class on all 15 questions related to promoting creative problem solving skills. However, the difference in scores between the two classes was insignificant. Overall, both the online and face-to-face classes scored well on the 13 selected questions. Based on the student responses to the Presentation evaluations, the author concluded that the Presentation assignment was effective in promoting creative problem solving skills for both the online and face-to-face classes.

Table X provides a summary and comparison of student responses to selected questions related to promoting creative problem solving skills from the online class on the Brief, Model and Presentation assignments.

TABLE X.
EVALUATION ON THE EFFECTIVENESS OF THE BRIEF, MODEL AND PRESENTATION (ASSIGNMENTS) IN PROMOTING CREATIVE PROBLEM SOLVING IN THE ONLINE CLASS

Class XXXXXX (Fall 2017)	Brief	Model	Presentation
Scale: 1. Strongly Disagree, 2. Disagree. 3. Neither Agree/Disagree, 4. Agree, 5. Strongly Agree	Average Score (Online Class)	Average Score (Online Class)	Average Score (Online Class)
1. Allowed me to use humor and play when generating ideas or solutions for the project problem.	4.24	4.24	4.00
2. Allowed me to express my creativity.	4.48	4.67	4.33
3. Allowed me to use the sketch to better understand that problem and/or generate ideas/solutions for the project problem.	4.33	4.29	4.0
4. Allowed me to use the steps or phases in the CPSP.	4.38	4.38	3.86
5. Seeing and/or physically examining the project problem, allowed me to better understand the problem and generate ideas/solutions.	4.24	4.24	3.76
6. Allowed me to recognize the benefits associated with different idea generation techniques.	4.52	4.38	4.05
7. Made it relatively easy for me to generate creative ideas or solutions for the project problem.	4.33	4.33	4.14
8. Allowed me to use my imagination when generating	4.81	4.48	4.14

ideas or solutions for the project problem.			
9. Allowed me to use incubation to understand the problem and/or generate ideas/solutions for the project problem.	4.38	4.24	4.05
10. Allowed the use of visualization to help me to better understand the problem and/or generate ideas or solutions for the project problem.	4.38	4.57	4.05
11. Allowed me to become familiar with different idea generation techniques.	4.57	4.48	4.14
12. Allowed me to use intuition when generating ideas or solutions for the project problem.	4.38	4.10	3.95
13. Allowed me to look for additional solutions for the project problem.	4.29	4.29	3.86
Number of Students	21	21	21

I. Summary:Online Class Evaluation on the Brief, Model and Presentation

When comparing the online student responses to selected questions evaluating the 3 sub-assignments or components of the CPS Assignment (Brief, Model and Presentation), the Brief scored highest on 6 questions and scored equal to the Model on 5 other questions. The Model scored highest on 2 questions and scored equal to the Brief on 5 other questions. The Presentation scored lower than the Brief and Model in promoting creative problem solving skills. However, based on the student responses, the author concluded that all 3 components of the CPS Assignment scored well for promoting creative problem solving skills for the online class.

Table XI provides a summary and comparison of student responses to selected questions related to promoting creative problem solving skills from the face-to-face class on the Brief, Model and Presentation assignments.

TABLE XI.
EVALUATION ON THE EFFECTIVENESS OF THE BRIEF, MODEL AND PRESENTATION (ASSIGNMENTS) IN PROMOTING CREATIVE PROBLEM SOLVING IN THE FACE-TO-FACE CLASS

Class XXXXXX (Fall 2017)	Brief	Model	Presentation
Scale: 1. Strongly Disagree, 2. Disagree. 3. Neither Agree/Disagree, 4. Agree, 5. Strongly Agree	Average Score (Face-to-Face Class)	Average Score (Face-to-Face Class)	Average Score (Face-to-Face Class)
1. Allowed me to use humor and play when generating ideas or solutions for the project problem.	4.42	4.69	4.54
2. Allowed me to express my creativity.	4.60	4.96	4.76
3. Allowed me to use the sketch to better understand that problem and/or generate ideas/solutions for the project problem.	4.27	4.69	4.27
4. Allowed me to use the steps or phases in the CPSP.	4.54	4.58	4.46
5. Seeing and/or physically examining the project problem, allowed me to better understand the problem and generate ideas/solutions.	4.58	4.58	4.50
6. Allowed me to recognize the benefits associated with different idea generation techniques.	4.65	4.62	4.46
7. Made it relatively easy for me to generate creative ideas or solutions for the project problem.	4.58	4.58	4.46
8. Allowed me to use my imagination when generating ideas or solutions for the project problem.	4.58	4.77	4.69
9. Allowed me to use incubation to	4.46	4.73	4.62

understand the problem and/or generate ideas/solutions for the project problem.			
10. Allowed the use of visualization to help me to better understand the problem and/or generate ideas or solutions for the project problem.	4.58	4.77	4.65
11. Allowed me to become familiar with different idea generation techniques.	4.54	4.62	4.58
12. Allowed me to use intuition when generating ideas or solutions for the project problem.	4.58	4.65	4.62
13. Allowed me to look for additional solutions for the project problem.	4.73	4.62	4.65
Number of Students	26	26	26

J. Summary:Face-to-Face Class Evaluation on the Brief, Model and Presentation

When comparing the face-to-face student responses to selected questions evaluating the 3 sub-assignments or components of the CPS Assignment (Brief, Model and Presentation), the Model scored highest on 8 questions and scored relatively equal to the Brief on 4 other questions. The Brief scored highest on 1 question and scored relatively equal to the Model on 4 other questions. The Presentation scored lower than the Brief and Model in promoting creative problem solving skills. However, based on the student responses, the author concluded that all 3 components of the CPS Assignment scored well for promoting creative problem solving skills for the face-to-face class.

V. IDEAS FOR FACULTY ON HOW TO DEVELOP ASSIGNMENTS FOR ONLINE AND FACE-TO-FACE COURSE DELLIVERY

Faculty need to look for every opportunity to create assignments for different modes of delivery. To help other engineering and technology faculty develop assignments for online and/or face-to-face course delivery, the author has identified the following set of guidelines.

A. Integrate One Assignment or All Assignments?

One question that should be addressed when considering the development of assignments for online and/or face-to-face course delivery is whether to put all assignments online or only a few assignments? In other words, a faculty can start the integration for different course delivery of assignments with one or a few assignments, or all the assignments at one time. The author has done both. Since the course that was the subject of this paper had an online and face-to-face section, the author was able to experience both types of course delivery simultaneously.

B. Recognize that Problem-Solving has Universal Application for Every Course

One type of assignment that has universal application, especially for engineering and technology courses, are problem solving assignments [4]. These types of assignments can be readily integrated into online and/or face-to-face course delivery. Since most engineering and technology courses deal with problems, problem solving can be integrated into almost every engineering and technology course without altering the course content. Consequently, integrating problem solving assignments from face-to-face and into online delivery or vice versa is a relatively easy modification to most courses.

C. Develop Assessment Instruments

Along with evaluating every course, faculty need to assess individual assignments to determine their effectiveness with online and/or face-to-face course delivery [11]. Some assessment tools that can be used to evaluate individual assignments for different modes of delivery can include those that were described in this paper: Pretest and Posttest, and student surveys of an individual assignment where different components of the assignment were evaluated.

D. Hybrid Course

Hybrid or Blended courses are a type of course delivery that integrates learning features of online and face-to-face course delivery [12]. Hybrid course assignments can be implemented either formally or informally. With the formal approach, the course can be designed and publicized by the academic department as a Hybrid course. As a result, students will be provided with advance notice of the assignment delivery. Using the informal approach, the individual faculty member can use his/her discretion to offer some assignments online.

E. Analyze the Components of an Assignment

One of the most difficult parts of problem solving is getting started. A problem may initially seem overwhelming, but if it is broken down into sub-assignments or its components, that will make getting started easier. In other words, most problems are often made up of a series of smaller problems. Different aspects of a (larger) problem can be submitted online and later discussed face-to-face. For example:

- Students can be required to provide responses online to specific questions about a problem that were developed by the instructor and later discuss those questions face-to-face in class.
- Students can be required to define the problem (Creative Challenge) and submit it online and later discuss the problem face-to-face in class.
- Students can be required to submit the introduction section of a problem (relevant facts of a problem) online and later discuss the introduction section face-to-face in class.

VI. CONCLUSION

Creative problem solving skills can benefit society, businesses and students when dealing with challenges presented by today's complex world. The author developed an assignment to teach students creative problem solving skills that will prepare them to deal with future challenges they will encounter after graduation. Based on the assessment described in the paper, he found that the CPS Assignment provided an effective method for promoting creative problem solving skills for both online and face-to-face classes.

In the paper, the author described the major components of the Creative Problem Solving Assignment. The paper identified the benefits derived from using the Assignment as a way to promote imagination and creative problem solving. Also, the author provided the results of the Assignment assessments related to developing problem solving skills. Finally, the paper identified guidelines that can be used by other engineering and technology faculty to develop assignments for different modes of course delivery.

REFERENCES

[1] S. Kinberg, "The Martian". Wikipedia, Available: https://en.wikipedia.org/wiki/The_Martian_(film). [Accessed Feb. 5, 2018].

[2] E. McGirt, "Grit is The New MBA", *Fortune Magazine*, Feb., pp. 54-62, 2018.

[3] R. Bradley, "Closing America's Idea Gap", *Fortune Magazine*, Dec., pp. 152-157, 2017.

[4] E. Lumsdaine, M. Lunsdaine, and J.W. Shelnutt, *Creative Problem Solving and Engineering Design*, McGraw-Hill, Inc., 1999, pp. 23-39, 153-171, 179-252, and 285-302.

[5] G.J. Puccio, M. Mance, and M.C. Murdock, *Creative Leadership*, SAGA Publications, Inc., 2011, pp. 31-46, 137-151, and 174-183.

[6] S.G. Isaksen, K.B. Dorval, and D.J.Treffinger, *Creative Approaches to Problem Solving*, SAGA Publication, Inc., 2011, pp. 1-109.

[7] D.J. Yovich. *Applied Creativity Manual and Worksheets*, 1997, pp. 137-154.

[8] J. Clements, "A New Challenge Beats Relaxation", *Money Magazine*, Oct., p. 36, 2016.

[9] C. McCollum, "Teaching Methods to Energize the Class", *The Times Newspaper*, 28 Nov., pp. A-1 and A-5, 2016.

[10] C. Rogers, "Cloud Sourced", *Prism Magazine*, Nov., p. 23, 2016.

[11] D. Eng, "How to Get Over Yourself", *Fortune Magazine*, Mar., p. 36, 2015.

[12] University of Wisconsin, UW Milwaukee. "Hybrid Courses: About Hybrid (Website)". Available: http://www4.uwm.edu/ltc/hybrid/about_hybrid/index.cfm.. [Accessed Jan. 31, 2018].

AUTHOR

R. Ocon is with Purdue University Northwest in Hammond, IN 46323 USA. He is in the department of Construction Science and Organizational Leadership, in the College of Technology (email: rocon@PNW.edu).

Submitted, April 2, 2019.