

Helping Students Solve Multidisciplinary Problems: A Project Technique Using Creative Problem Solving

Ralph Ocon

Construction Science and Organizational Leadership
Purdue University Northwest
Hammond, IN 46323, USA
rocon@pnw.edu

Abstract

Today, regardless of the business or industry involved, graduates will need the skills required to solve various workplace issues. For several years, the author used a project technique with creative problem solving projects to help students understand and resolve a multitude of contemporary problems, including those in engineering, technology and business. Recognizing the variety and complexity of workplace issues, and the relevance and adaptability of creative problem-solving to situations in different disciplines, the author developed a project technique to help students understand and solve multidisciplinary problems. The technique involved several components, including a requirement for students to create a physical model representing the solution for those problems. To ensure an accurate and thorough evaluation of the project technique, the author used several assessment instruments. In the paper, the author described and evaluated the major components of the project technique. The author identified the benefits derived from using the technique as a way to learn about different workplace issues and develop solutions for those concerns. Also, pretests and posttests were administered to compare student understanding of creative problem solving and the specific workplace issues involved. Finally, the author provided responses to student comments/suggestions for improving the project technique.

Keywords

Project Technique, Creative Problem-Solving (CPS), Multidisciplinary Problems

1. Introduction

As they pursue their careers, graduates will need creative solutions for the wide variety of work-related challenges they will encounter. According a 2023 job outlook survey, “more than 60% of employers are seeking evidence of graduates’ abilities to solve problems and work in teams (Gray 2023).” Recognizing the roles students will assume as future professionals and leaders (De Janasz 2019), the author developed a multidisciplinary project technique to help students use creative problem-solving to learn about and solve workplace problems in various disciplines. “The 21st century will be the century of creativity. Additionally, one key quality of many creative jobs is that they are resistant to automation. In the U.S., 86 percent of workers in the highly creative category are found to be at low or no risk of automation ((Upstart Co-Lab 2023).”

Until recently, there was a tendency to associate creativity with only the arts, such as painting, dancing, acting and music (Taylor 2013), (Hawkins 2017). “Jobs in the creative economy go far beyond employing artists and designers. 10.3 million jobs or nearly 10 percent of the total U.S. employment is in the creative economy (Upstart Co-Lab 2023).” “The author’s interest and research in creativity led him to envision ways for students to use their creativity in other disciplines. Over the years he persevered in applying creativity to disciplines outside the arts, such as engineering, technology or business situations. The integration of creativity concepts and different problem-solving approaches helped the author recognize that creative problem-solving can be used to solve a multitude of problems in various disciplines, such as ethics, diversity and workplace safety and environmental issues. Relying on his research and experience with previous multidisciplinary learning projects, the author used the relevant components from those projects to create the current project technique (Ocon 2021).”

2. Benefits of the Project Technique

The project technique was used with multidisciplinary learning projects that combined creative problem-solving and different workplace issues in various disciplines. Because the project required students to conduct research on an assigned topic in a selected discipline, the author’s expertise on a given work-related topic and/or discipline was not required for the success of the projects. As a result, students researched and presented the assigned topics and in the process developed their expertise. A by-product of the project assignments was that the author gained knowledge of various topics in a given discipline by interacting with students and listening to the presentations. Table 1 lists some of the major benefits students derived from the project technique (Ocon 2021), (Lumsdaine, Lumsdaine and Shelnut 1999), (Isaksen, Dorval and Treffinger. 2011), (Zielinski 2018), (Black 1995).

Table 1. Benefits derived from the project technique

| |
|--|
| • An effective way to learn about various workplace concerns and creative problem-solving |
| • Instructor expertise for a selected project topic (in a given discipline) was not required |
| • Highlighted the importance of building a physical model to promote the understanding of workplace problems and creative solutions for those problems |
| • Checkpoints throughout the project encouraged students to take personal responsibility for the completion of the project |
| • Helped students recognize the importance of various workplace concerns for their careers |
| • Promoted the use of incubation, intuition, sketching and visualization for understanding and/or developing ideas for problem-solving |
| • Allowed students to recognize that everyone has creative potential/ability |
| • Promoted the use/familiarity with idea generation techniques for problem-solving |
| • Highlighted the use of multidisciplinary learning: creative problem-solving and various workplace concerns |
| • Promoted the importance of developing creative thinking skills for problem-solving |
| • Promoted the search for multiple solutions for problems |
| • Allowed students to recognize that creative thinking skills can promote the understanding of various workplace issues |
| • Allowed students to use their imaginations to find solutions for work-related concerns |
| • Provided an interesting way to learn about workplace concerns and creative problem-solving |
| • Provided students with opportunities to use and develop their communication skills |
| • Promoted the recognition that multidisciplinary learning projects/assignments can be used in other courses/disciplines |

3. The Project Technique

Use of the project technique did not require any specialized technical knowledge or expertise by a faculty member. “The (project technique used with each project was based) on 3 major components, brief (briefs 1 and 2), physical model and PowerPoint presentation, which were designed to complement each other to help students understand creative problem-solving and different workplace concerns (in different disciplines). The concept involving the 3 components was successfully used by the author with previous projects” (Ocon 2021).”

As was true with previous projects, “the different due dates, during the semester, created a time line for the project components completion and provided students with constant reminders of the project (Merrick 2019). The due dates for the components completion followed (an established) pattern for projects the author used in the past (Ocon 2021).” For example:

- “Throughout the semester, “students learned about creativity and the Creative Problem Solving Process (Ocon 2021; De Janasz 2019: Lumsdaine, Lumsdaine and Shelnut 1999; Isaksen, Dorval and Treffinger 2011; Yovich 1997; Michalko 2001; Hanson 2015). As the semester progressed, students were required to submit the components of the project at different times. The project brief was due in Week 8, photos of the physical model in Week 12 and the PowerPoint presentations on the project in Week 14 (Ocon 2021).”
- “Students (and the author) evaluated each component (briefs, model, and presentation) of the project, along with giving feedback on the project in general. Tables 5, 7, 8 and 9 provide summaries of student responses to selected questions related to the project components (Ocon 2021).”

Depending on the semester, the projects included different workplace issues within a given discipline, such as ethics, diversity, workplace safety and environmental issues. The author assigned each student an issue for their project. A major benefit of the project format was that students were able to engage in research and develop expertise in their assigned topic, while the author focused on developing student expertise in creative problem-solving. The project timeline and checkpoints, not only encouraged students to successfully complete the major project tasks, but allowed the author to evaluate, monitor and track the different project components (De Janasz 2019). An example of topics/issues in the discipline of workplace safety are listed in Table 2 (Goetsch 2015), (Friend and Kohn 2007).

Table 2. Examples of assigned workplace safety issues/concerns

| |
|--|
| 1. How to encourage employees to wear personal protective equipment? |
| 2. How to correct/remedy workplace injuries resulting from inadequate safety training? |
| 3. How to encourage/promote machinery/equipment maintenance? |
| 4. How to change long term employee hazardous work practices/behavior? |
| 5. How can employees implement/administer first aid? |
| 6. How to avoid/limit employee carelessness? |
| 7. How to avoid/limit employee slips, trips and falls hazards? |
| 8. How to avoid/limit workplace fire hazards? |
| 9. How to avoid/limit ergonomic hazards in the workplace? |
| 10. How to limit/reduce biological hazards in the workplace? |
| 11. How to reduce/eliminate clutter in the work environment? |
| 12. How to limit/reduce workplace toxic chemicals and fumes hazards? |
| 13. How to properly control/manage hazardous energy in the workplace? |
| 14. How to encourage employees to follow emergency procedures? |
| 15. How to improve effective workplace communication? |

3.1 Project brief

A major component for the project technique was for students to develop a project brief for the assigned project. “A brief is a problem-solving tool the author required for projects. The brief encouraged students to think about and incubate their assigned issue, and plan the creation of the model and presentation. The author distributed a handout to students which defined and described the purpose of a brief. The handout stated that a brief was a creative thinking tool that problem-solvers use to: (1) begin the process of solving a problem (2) stimulate the imagination for creative ideas, and (3) develop and organize ideas for finding solutions. Putting thoughts/ideas into a written brief is an effective way to improve ideas and follow through on solving problems (Ocon 2021), (Makdisi and Makdisi 2009).” Using the Workplace Safety Project as an example, Table 3 listed the 13 components for the safety brief-1 (Ocon 2021).

Table 3. The 13 components of the safety brief-1

| |
|--|
| 1. Provide a creative title for the solution to the safety issue/concern |
| 2. Background information on the safety issue/concern |
| 3. Explain why a solution to the safety issue/concern is important today |
| 4. Describe the solution for the safety issue/concern |
| 5. How can the solution for the safety issue/concern be achieved/implemented in the workplace |
| 6. Create an acronym for implementing the solution |
| 7. The “Problem as Stated” |
| 8. The “Problem as Understood” |
| 9. A written description of the 3-D Model of the safety solution the student is constructing |
| 10. What was the alternative idea for constructing a model of the safety solution |
| 11. Identify the main idea generation technique(s) used/to be used to stimulate your imagination for the model |
| 12. A sketch of the 3-D Model |
| 13. How can the brief be improved |

3.2 Model

“The second major component of the project technique required students to use their creativity to build a physical model of their solution. Building a model encouraged students to continuously think about their assigned issue

throughout the semester (Merrick 2019). The model reinforced the understanding of the issues, while complementing the other components of the project. From past experience, the author recognized the importance of providing students with some structure, such as by limiting the size of the model and (specifying the) construction materials to be used when building the model. At the same time, these (parameters) allowed for consistent criteria that helped the author when grading the project. (With recent projects) the model had to be: (1) constructed (at least 70%) of Play-Doh or modeling dough and (2) limited in size, not to exceed 8 inches (height), by 8 inches (width), by 8 inches (length) (Ocon 2021).”

3.3 PowerPoint presentation

“The third and last major component (for the project technique) was a 5-minute PowerPoint presentation. Students were required to provide a presentation and describe the (assigned) issue and model. For those students who were unclear or sought advice on what to include in their presentation, the author would suggest the components of the brief-1 as a guide for the presentation. The presentation component of the project was designed to reinforce and complement the understanding of the assigned workplace issue (Ocon 2021).”

4. Methodology and Assessment of the Project Technique

The author’s experience with previous projects provided him with the perspective for developing the project technique and thorough evaluation of the different components of each project. The effectiveness of the technique in promoting the understanding of creative problem-solving and various workplace problems was determined by using a variety of assessment tools. As with previous projects, the author used similar assessment instruments to evaluate the major components (Ocon 2021).

Hypothesis: The project technique will result in an increase in student understanding of selected workplace issues and creative problem solving. The average rating results, over 9 semesters, for the 3 major components of the projects: brief-2, physical model and PowerPoint presentation, on a scale from 1 (strongly disagree) - 5 (strongly agree) will be ≥ 4 (agree) on selected questions. A rating result of ≤ 3.50 (midpoint of “neither agree nor disagree”) on the brief-2, model or presentation components would be unacceptable.

4.1 Project brief-1 assessments

“One of the most difficult aspects of any project (or assignment) is avoiding procrastination and getting student off to a good start (De Janasz 2015). In evaluating the components of the brief, the author continued to use two different assessments (Ocon 2021). Recognizing the importance of a brief in successfully starting, implementing and completing the project, the author evaluated the brief twice (Makdisi and Makdisi 2009). The first brief (brief-1) assessment focused on the different components of the brief, as they related to promoting the specific workplace issue, and creative problem-solving understanding and the development of the model. The second brief (brief-2) compared the effectiveness of the brief with the other two components (physical model and PowerPoint presentation) of the project. Using the Workplace Safety Project as an example, Table 4 listed selected questions on the safety brief-1 (Ocon 2021).” Similar questions were used with the Ethics, Diversity and Environment Issues Projects.

Table 4. Selected questions on the safety brief-1

| |
|---|
| Question 1: A creative title for the solution to the safety issue/concern- is important in promoting safety understanding, imagination and/or creative problem solving |
| Question 2: Background information on the safety issue/concern- is important in promoting safety understanding, imagination and/or creative problem solving |
| Question 3: Explain why a solution to the safety issue/concern is important- is important in promoting safety understanding, imagination and/or creative problem solving |
| Question 4: Describe the solution for the safety issue/concern- is important in promoting safety understanding, imagination and/or creative problem solving |
| Question 5: How the solution for the safety issue/concern will be achieved/implemented- is important in promoting safety understanding, imagination and/or creative problem solving |
| Question 6: The written description of the 3-D physical model- is important in promoting safety understanding, imagination and/or creative problem solving |
| Question 7. A sketch (the best idea) of the 3-D model- is important in promoting safety understanding, imagination, and/or creative problem solving. |

Table 5 provides a summary and comparison of student responses, over 9 semesters, to selected questions on the brief-1 for the Ethics Project, Diversity Project, Workplace Safety Project and the Environmental Issues Project in promoting workplace issues and creative problem-solving understanding.

Table 5. 9 semester summary and comparison to selected questions on the components of the safety brief-1 in promoting ethics, diversity, safety and environmental issues understanding and creative problem solving

| (Class XXXX) Spring 2019 -Spring 2023 | Ethics Brief-1 (S19, F19, S20)) | Diversity Brief-1 (F20, S21) | Safety Brief-1 (F21, S22) | Envir. Issues Brief-1 (F22, S23) | Summation-Brief-1 (Spring 2019-Spring 2023) |
|---|---------------------------------|------------------------------|---------------------------|----------------------------------|---|
| <u>Scale:</u> 1. Strongly Disagree, 2. Disagree, 3. Neither Agree/Disagree, 4. Agree, 5. Strongly Agree | 3 Semester Average Scores | 2 Semester Average Scores | 2 Semester Average Scores | 2 Semester Average Scores | Summation of 9 Semester Average Scores |
| Question 1-Title | 4.27 | 3.77 | 4.09 | 4.09 | 4.06 |
| Question 2-Background | 4.14 | 4.29 | 4.60 | 4.79 | 4.46 |
| Question 3-Importance | *NA | 4.42 | 4.55 | 4.49 | 4.49 |
| Question 4-Solution | *NA | 4.37 | 4.69 | 4.57 | 4.54 |
| Question 5-Implement | *NA | 4.30 | 4.59 | 4.44 | 4.44 |
| Question 6-Description | 4.13 | 3.52 | 3.71 | 3.49 | 3.72 |
| Question 7-Sketch | 4.06 | 3.60 | 3.72 | 3.94 | 3.83 |
| (Avg.) Number of Students | 19 | 23 | 38 | 34 | 29 |

*NA: no data available

Table 5 showed that the average scores, over 9 semesters, for the 7 selected questions on the brief-1 components had 5 scores above 4.0, and 2 scores of 3.71, for Question 6 and 3.72 for Question 7. Any differences in scores from 4.0 for Questions 6 and 7 were negligible. However, the author will continue to monitor and evaluate Questions 6 and 7 for any future projects. Based on the student responses to brief-1 evaluation, the author concluded that brief-1 was effective in promoting student understanding of the selected workplace issues and creative problem-solving.

4.2 An example of selected questions applied to the brief-2, model and presentation for the workplace safety project

The author evaluated the brief-2, physical model and PowerPoint presentation using selected questions for the workplace issues and creative problem-solving. Using the Workplace Safety Project as an example, Table 6 listed the questions for the assessments of the brief-2, model and presentation. Similar questions were used with the Ethics, Diversity and Environment Issues Projects.

Table 6. Selected questions applied to the assessments of the brief-2, model and presentation for the safety project

| |
|---|
| 1. Allowed me to express my creativity |
| 2. Allowed me to use the sketch to better understand safety issues/concerns and/or generate ideas for the SMP |
| 3. Allowed me to use the steps or phases in the Creative Problem Solving Process |
| 4. Seeing and/or physically examining the safety model allowed me to better understand the safety issues/concerns and generate ideas for completing the project |
| 5. Made it relatively easy for me to understand safety issues/concerns and generate creative ideas for completing the SMP |
| 6. Allowed me to use my imagination when generating ideas for completing the SMP |
| 7. Allowed the use of visualization to help me to better understand the safety issues/concerns and/or generate ideas for completing the Safety Model Project |
| 8. Allowed me to become familiar with different safety issues/concerns |
| 9. Improved my understanding of safety issues/concerns |
| 10. Provided an interesting way to learn about safety issues/concerns |
| 11. Improved my understanding of creative problem solving |
| 12. Provided an interesting way to learn about creative problem solving |
| 13. The Safety Model Project is relevant for my career |

4.3 Evaluation of the brief-2

Table 7 provides a summary and comparison of student responses, over 9 semesters, to selected questions on the brief-2 for the Ethics Project, Diversity Project, Workplace Safety Project and the Environmental Issues Project in promoting workplace issues and creative problem solving understanding.

Table 7. 9 semester summary and comparison of student responses to selected questions on the brief-2 in promoting ethical, diversity, safety and environmental issues understanding

| (Class XXXX) Spring 2019-Spring 2023 | Ethics- Briefs2 (S19, F19, S20) | Diversity- Briefs2 (F20 and S21) | Safety- Briefs2 (F21 and S22) | Envir. Issues Brief2 (F220 and S23) | Summation- Brief2 (Spring 2019- Spring 2023) |
|---|--|--|--|---|---|
| Scale: 1. Strongly Disagree, 2. Disagree, 3. Neither Agree/Disagree, 4. Agree, 5. Strongly Agree | 3 Semester Average Scores | 2 Semester Average Scores | 2 Semester Average Scores | 2 Semester Average Scores | Summation of 9 Semester Average Scores |
| Question 1-Express | 4.06 | 3.80 | 4.13 | 3.96 | 3.99 |
| Question 2-Sketch | 3.97 | 3.88 | 4.23 | 4.27 | 4.09 |
| Question 3-Phases | 4.26 | 4.19 | 4.42 | 4.36 | 4.31 |
| Question 4-See | 4.07 | 3.74 | 4.09 | 3.80 | 3.93 |
| Question 5-Understand | 4.36 | 4.07 | 4.54 | 4.40 | 4.34 |
| Question 6-Imagination | 4.15 | 4.07 | 4.38 | 4.37 | 4.24 |
| Question 7-Visualize | 3.78 | 3.98 | 4.05 | 3.84 | 3.91 |
| Question 8-Familiar | 3.99 | 3.98 | 4.12 | 4.25 | 4.09 |
| Question 9-Understand | 4.34 | 4.29 | 4.48 | 4.53 | 4.41 |
| Question 10-Interesting | 4.15 | 4.11 | 4.47 | 4.23 | 4.24 |
| Question 11-Understand | 4.30 | 4.12 | 4.57 | 4.50 | 4.37 |
| Question 12-Interesting | 4.17 | 3.96 | 4.42 | 4.24 | 4.20 |
| Question 13-Relevant | 4.28 | 3.63 | 4.17 | 3.70 | 3.95 |
| (Avg.) Number of students | 17 | 22 | 35 | 32 | 27 |

Table 7 showed that for 9 of the 13 selected questions the average score, over 9 semesters, for the project brief-2 components were greater than 4.0. The remaining 4 questions (Questions 1, 4, 7 and 13) had average scores of 3.90

or greater- any differences from 4.0 were negligible. Based on student responses, the author concluded that the project brief-2 was effective in promoting student understanding of the selected workplace issues and creative problem solving.

4.4 Model

Table 8 provides a summary and comparison of student responses, over 9 semesters, to selected questions on the physical model for the Ethics Project, Diversity Project, Workplace Safety Project and the Environmental Issues Project in promoting workplace issues and creative problem solving understanding.

Table 8. 9 semester summary and comparison to selected questions on the model in promoting ethics, diversity, safety, and environmental issues understanding

| (Class XXXX) Spring 2019-Spring 2023 | Ethics Model (S19, F19, S20) | Diversity Model (F20 and S21) | Safety Model (F21 and S22) | Envir. Issues Model (F22 and S23) | Summation- Model (Spring 2019- Spring 2023) |
|---|------------------------------------|-------------------------------------|----------------------------------|---|--|
| Scale: 1. Strongly Disagree, 2. Disagree, 3. Neither Agree/Disagree, 4. Agree, 5. Strongly Agree | 3 Semester Average Scores | 2 Semester Average Scores | 2 Semester Average Scores | 2 Semester Average Scores | Summation of 9 Semester Average Scores |
| Question 1-Express | 4.63 | 4.43 | 4.71 | 4.62 | 4.60 |
| Question 2-Sketch | 4.36 | 3.97 | 4.42 | 4.32 | 4.27 |
| Question 3-Phrases | 4.08 | 3.89 | 4.32 | 4.08 | 4.09 |
| Question 4-See | 4.23 | 3.92 | 4.24 | 4.34 | 4.18 |
| Question 5-Understand | 4.15 | 4.02 | 4.29 | 4.21 | 4.17 |
| Question 6-Imagination | 4.54 | 4.37 | 4.70 | 4.71 | 4.58 |
| Question 7-Visualize | 4.45 | 4.37 | 4.67 | 4.71 | 4.55 |
| Question 8-Familiar | 3.87 | 3.85 | 3.98 | 3.72 | 3.86 |
| Question 9-Understand | 4.21 | 4.17 | 4.18 | 4.07 | 4.16 |
| Question 10-Interesting | 4.54 | 4.29 | 4.77 | 4.55 | 4.54 |
| Question 11-Understand | 4.08 | 4.31 | 4.45 | 4.24 | 4.27 |
| Question 12-Interesting | 4.37 | 4.51 | 4.67 | 4.40 | 4.49 |
| Question 13-Relevant | 4.19 | 3.83 | 4.10 | 3.67 | 3.95 |
| (Avg.) Number of students | 17 | 22 | 35 | 33 | 27 |

Table 8 showed that the average scores, over 9 semesters, for selected questions on the project models were over 4.0 (with the exception of Questions 8 and 13). However, the average score for Question 8 was 3.86 and Question 13 was 3.95- any difference in scores for those questions was insignificant compared to 4.0. However, the author will continue to monitor and evaluate Questions 8 and 13 for any future projects. Based on the student responses, the author concluded that the project model component was effective in promoting student understanding of various workplace issues and creative problem solving.

4.5 PowerPoint presentation

Table 9 provides a summary and comparison of student responses, over 9 semesters, to selected questions on the PowerPoint presentation for the Ethics Project, Diversity Project, Workplace Safety Project and the Environmental Issues Project in promoting the selected workplace issues and creative problem-solving understanding.

Table 9. 9 semester summary and comparison of student responses to selected questions on the presentation in promoting ethics, diversity, safety, and environmental issues understanding

| (Class XXXX) Spring 2019- Spring 2023 | Ethics Presentation (S19, F19, S20) | Diversity Presentation (F20 and S21) | Safety Presentation (F21 and S22) | Envir. Issues Presentation (F22 and S23) | Summation- Presentation (Spring 2019- Spring 2023) |
|---|--|--|--|--|---|
| Scale: 1. Strongly Disagree, 2. Disagree, 3. Neither Agree/Disagree, 4. Agree, 5. Strongly Agree | 3 Semester Average Scores | 2 Semester Average Scores | 2 Semester Average Scores | 2 Semester Average Scores | Summation of 9 Semester Average Scores |
| Question 1-Express | 4.38 | 4.12 | 4.29 | 4.18 | 4.24 |
| Question 2-Sketch | 3.95 | 3.86 | 4.03 | 3.96 | 3.95 |
| Question 3-Phases | 4.30 | 4.02 | 4.24 | 4.15 | 4.18 |
| Question 4-See | 4.10 | 3.93 | 3.96 | 4.08 | 4.02 |
| Question 5-Understand | 4.24 | 4.28 | 4.17 | 4.32 | 4.25 |
| Question 6-Imagine | 4.26 | 4.10 | 4.18 | 4.09 | 4.16 |
| Question 7-Visualize | 4.30 | 4.07 | 4.30 | 4.21 | 4.22 |
| Question 8-Familiar | 4.23 | 3.85 | 3.97 | 4.02 | 4.02 |
| Question 9-Understand | 4.37 | 4.29 | 4.21 | 4.43 | 4.33 |
| Question 10 –Interest | 4.50 | 4.27 | 4.35 | 4.41 | 4.38 |
| Question 11-Understand | 4.37 | 4.21 | 4.31 | 4.28 | 4.29 |
| Question 12-Interest | 4.35 | 4.11 | 4.32 | 4.10 | 4.22 |
| Question 13-Relevant | 4.43 | 3.76 | 4.22 | 3.71 | 4.03 |
| (Avg.) Number of students | 17 | 22 | 35 | 33 | 27 |

Table 9 showed that the average score for 12 of 13 selected questions, over 9 semesters, on the PowerPoint presentation component was over 4.0. The average scores, over 9 semesters, for Question 2 was 3.95- any difference in scores for that question was insignificant compared to 4.0. However, the author will continue to monitor and evaluate Questions 2 for any future projects. Based on the student responses, the author concluded that the PowerPoint presentation component was effective in promoting student understanding of various workplace issues and creative problem solving.

5. Pretest and posttest

As previously stated, each semester the author administered a true/false pretest on the selected workplace issue and creative problem-solving at the beginning of the semester and posttest at the end of the semester. The pretest and posttest were intended to measure the before and after situations for student learning. Using the Workplace Safety Project as an example, Table 10 listed the True/False Questions for the pretest and posttest. Similar questions were used with the Ethics, Diversity and Environmental Issues Project.

Table 10. List of true/false questions for the pretest and posttest on the safety project.

| |
|---|
| 1. Most people remember and/or understand what they see better than what they hear |
| 2. Humor and play should be avoided when we are generating ideas to help solve problems |
| 3. Workplace safety issues are important to me. |
| 4. When dealing with safety issues/concerns, we should follow this philosophy. “if it’s not broke-don’t fix it” |
| 5. It is easier to turn wild/unusual ideas into practical solutions than to turn routine/obvious ideas into innovative solutions |
| 6. Creativity is a personal characteristic that only a select few possess |
| 7. Sketching is an effective creative problem solving tool |
| 8. Creative thinking skills can promote the understanding of safety issues/concerns |
| 9. Creativity is a process involving a sequence of several steps or phases |
| 10. Most people understand a problem or situation better if they can physically see and examine or touch it, instead of just thinking about the problem |
| 11. Creative thinking skills can promote the solving of safety issues/concerns |
| 12. Working or behaving in a safe manner is important for my career success |
| 13. Safety training can reduce workplace accidents and injuries |
| 14. Incubating an idea is not an effective way to understand and/or develop ideas |
| 15. Visualization is an effective way to understand and solve problems |
| 16. I am familiar with at least 3 idea generation techniques |
| 17. When solving problems or making decisions we should avoid using intuition |
| 18. After finding a good solution to a problem, we should avoid looking for additional solutions for that problem |
| 19. Having creative thinking skills are important for career success |
| 20. Most people will experience a workplace safety dilemma sometime during their career |
| 21. Workplace safety behaviors/habits can be learned |
| 22. The majority of workplace accidents/injuries are unavoidable |
| 23. Using common sense is an effective way for most employees to avoid workplace accidents/injuries and work safely without formal safety training |
| 24. If employees work in an office environment, they don’t have to worry about workplace hazards |

5.1 Pretest and posttest

Table 11 provided the percent of correct responses to questions from the pretest and posttest for the Ethics, Diversity, Workplace Safety and Environmental Issues Projects.

Table 11. Results from the ethics, diversity, safety and envir. issues projects pretest and posttest over 9 semesters

| Semester | (Ethics and CPS) 3 Semester Average (Spring 2019, Fall 2019 and Spring 2020) | (Diversity and CPS) 2 Semester Average (Fall 2020 and Spring 2021) | (Safety and CPS) 2 Semester Average (Fall 2021 and Spring 2022) | (Envir. Issues and CPS) 2 Semester Average (Fall 2022 and Spring 2023) | Summation of Pretest and Posttest scores (Spring 2019-Spring 2023) |
|---------------|--|--|---|--|--|
| Pretest | 82% | 81% | 88% | 89% | 85% |
| # of Students | 17 students | 25 Students | 40 Students | 39 Students | 30 Students |
| Posttest | 95% | 87% | 95% | 93% | 93% |
| # of Students | 19 students | 23 Students | 38 Students | 33 Students | 28 Students |

The pretest and posttest scores indicated a consistent pattern of encouraging results. For the Ethics Project the average change from the pretest to the posttest was a positive 13 percentage points improvement (from 82% to 95%). For the Diversity Project the average change from the pretest to the posttest was a positive 6 percentage points improvement (from 81% to 87%). For the Workplace Safety Project the average change from the pretest to the posttest was a positive 7 percentage points improvement (from 88% to 95%). For the Environmental Issues

Project, the average change from the pretest to the posttest was a positive 4 percentage points improvement (from 89% to 93%). Over 9 semesters, the average change for the various projects from different disciplines, from the pretest to the posttest was a positive 8 percentage points improvement (from 85% to 93%).

6. Student Comments and/or Suggestions and Author's Response

Part of the project technique evaluation encouraged students to write comments and/or suggestions on ways to improve the technique. Below, the author summarized, paraphrased and/or combined student comments for improvements. Some students chose not to provide responses/comments for any improvement. The majority of comments for improvement, involved the model (materials allowed for building the model, model size, etc.). Below, the author responded to student comments/suggestions for improving the project assignments.

1. Provide examples of previous project model?

Author's response:

- By not providing examples of previous models, the author wanted to promote individual creativity and prevent students from copying previous models.
- In the course, the author emphasized the benefits of not knowing or innocence to promote creativity and innovation.

2. Consider the use of student teams?

Author's response:

- By requiring individual projects/models, the author was able to hold each student accountable for his/her project.
- Although the author recognized the benefits of teams, such as the potential to build-on and improve existing projects/models, the author was attempting to develop individual creativity.

3. Allow the use of different materials to build the model?

Author's response:

- From the author's previous experience with the project/model assignments, many students indicated the desire/requested more guidance on materials for building the model.
- To promote consistency for assessing/grading the models and limiting costs, the author placed limitations on the materials and dimensions.
- In the workplace, students will have to deal with job/task/assignment constraints during their careers.
- In the past (with some previous projects), the author allowed students to use different materials, including popsicle sticks, arts & craft materials and/or leaving it up to students to choose/decide on the model building materials and dimensions- however, with recent projects, the author chose to provide students with more structure/guidance on the use of model materials and dimensions.

4. Allow students to choose the project topic?

Author's response:

- With previous projects, many students were unsure on what topic to choose and requested/preferred more guidance and structure from the author.
- Providing a list of topics to choose from gave students some guidance on relevant and acceptable topics in a given discipline.
- Assigning topics/the discipline, limited the potential of copying (cheating) from previous semester projects.
- With some previous projects, the author allowed students to choose their topic- however, with recent projects, the author chose to provide students with more structure by using a list of assigned topics (in a given discipline).

5. Why do students need to follow the project phases (sub-assignments) with different due dates (e.g., briefs, model and presentation) throughout the semester?

Author's response:

- Based on previous experience, the benefits of using phases and different due dates were an important aspect of project completion and success.

- The different due dates during the semester for the completion of project components, created an established time-line for the project components completion and provided students with constant reminders of the project.

7. Conclusion

Work-related problems will continue to affect the success and careers of graduating students. Therefore, it's important for students to develop problem-solving skills for resolving those concerns. The project technique was an effective way to combine creative problem-solving with various workplace issues to promote the understanding and effective solving of those concerns. Based on the assessment results, the overall conclusion was that the author's approach for project assignments provided an effective multidisciplinary learning method that allowed students to use creativity to promote increased understanding of problems in different disciplines.

In the paper, the major components of the project technique were described and evaluated over the course of 9 semesters, involving different topics from different disciplines. The author identified the benefits derived from using the technique as a way to learn about workplace issues and use creativity to develop solutions for those concerns. Also, pretests and posttests were administered to compare student understanding of creative problem-solving and selected workplace issues in general. Finally, the author provided responses to student comments and suggestions for improving the project methodology.

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Biography

Ralph Ocon is a Professor in the Department of Construction Science and Organizational Leadership at Purdue University Northwest, Hammond, Indiana, USA. He has a B.A. in Education, M.A. in Teaching Economics., and

M.S. in Management from Purdue University in West Lafayette, Indiana, in addition to a law degree from Indiana University in Bloomington, Indiana. Professor Ocon teaches courses in creative problem-solving, leadership, and diversity management. From 1983-1990, Professor Ocon was the Director of the Center for Economic Education, and from 1990- 2002, he served as the university's Equal Employment Opportunity Officer.