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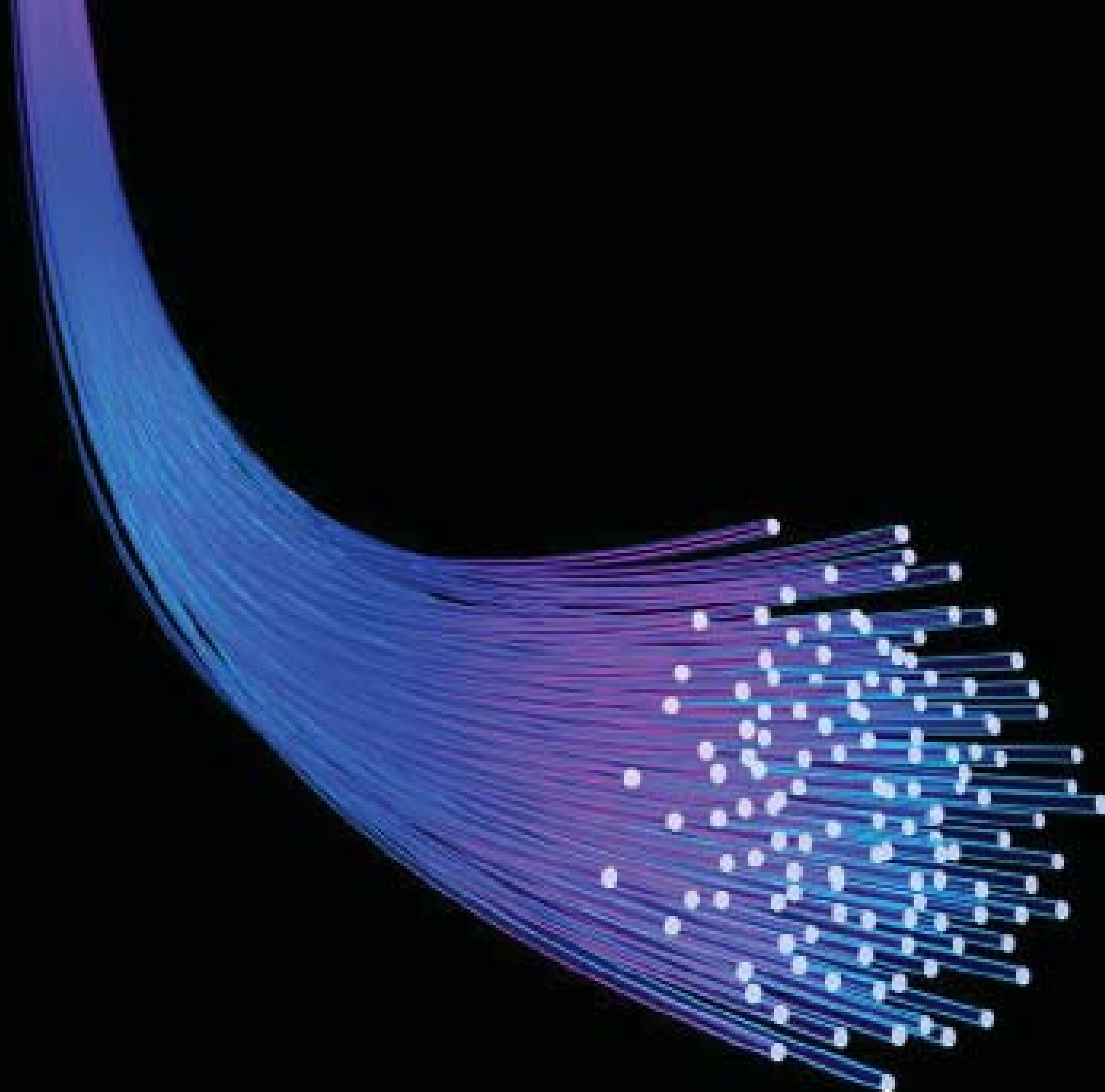

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Efficacy of a STEM Program: POWER Camp

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Abstract

Indiana University Purdue University Indianapolis (IUPUI) hosts an annual summer camp for high school girls, called POWER Camp that introduces participants to the engineering field. The purpose of this study was to determine the efficacy of the POWER Camp in improving the perceptions of the participants regarding desire to pursue an Engineering career and perceived success in Engineering.

Having a balanced number of women to men in STEM careers is beneficial, thus it is important to understand the perceptions of women regarding STEM fields in order to make work in these areas more attractive and desirable for females. This study surveyed the participants of the 2011 IUPUI POWER Camp in an effort to establish the program's effectiveness. The Correlated-Groups t test was used to statistically validate the perceived effectiveness of this program. This research is significant in that it adds to the body of knowledge regarding female perceptions of STEM fields and their pursuit of STEM careers.

Introduction

Over the past few decades it has become increasingly necessary for women to get out of the home and enter the workforce. This has led to an increase in the female presence on college and university campuses and the number and types of jobs that women are now choosing to pursue (Bureau of Labor Statistics, 2006). Even though women are more prevalent on jobsites, there are still some industries that remain male-dominated and often these include Science, Technology, Engineering, and Mathematics (STEM) fields. There are many factors that play a role in women either not having a desire to enter into or not continuing their careers in the STEM fields. These factors range from educational interest to on-the-job issues (Kossuth, 2003). Studies have also shown that women are more interested in careers that they feel add value to society (Miller, 2000). Often, when engineering is promoted as a profession, it is not advertised in a manner that shows relevance to society (Farrell, 2002).

There are now a number of STEM-based programs that were created to foster awareness and interest in young people to seek secondary education and careers in the STEM fields. These programs are offered by many different organizations such as the Build IT program sponsored by Girls, Inc. (Koch, 2010). Project Lead the Way (PLTW, 2011) is a national program that works to promote pre-engineering courses at middle schools and high schools. Olin College sponsors a program in which Olin College students mentor local high school students who are participating in FIRST (For Inspiration and

Recognition of Science and Technology) (Kossuth, 2004). Indiana University Purdue University Indianapolis sponsors MEAP (Minority Engineering Advancement Program) to assist with the advancement of groups typically underrepresented in engineering fields (MEAP, 2011). STEM Club was created to tutor and encourage youth taking STEM related courses, (STEM Club, 2011). Finally, Pathways to Engineering encourages interest and academic preparedness among elementary, middle school and high school students in several of the Indianapolis public schools (Central Indiana I-STEM Network, 2011).

STEM curriculum tends to be more of interest to males than females, so there are some STEM programs that have been developed for females only. These are designed to increase female interest in STEM education by allowing girls to apply their knowledge to real-world situations through hands-on activities. The sponsors of these programs have hopes of attracting more females to STEM fields. The state of New Hampshire sponsors a Lego and robotics program specifically for girls (Kossuth, 2004). The University of Wisconsin sponsors several programs that focus on attracting females to STEM fields including Women in Engineering Career Day, Sky's the Limit, and Piecing It All Together (Landgraf, 2008). At Indiana University Purdue University Indianapolis, a camp has been developed called Preparing Outstanding Women for Engineering Roles (POWER, 2011). Certainly various experiences have been developed and offered to underrepresented minorities, especially females, to entice them to consider STEM careers. Research, however, must be conducted to see if these programs are working, and if they can be replicated nationally to help the U.S. become more competitive by recruiting and retaining females and minorities in STEM fields.

Literature Review

The Discrepancy of Women to Men in the STEM Workforce

The roles of women in the United States have shifted drastically in a relatively short period of time. More women are taking up careers instead of staying at home rearing children on a full-time basis. In an effort to make this possible the United States government has enacted laws to protect women and make workplaces equitable to men and women. Although the possibility for women to gain access into what used to be considered male dominated careers has increased, there is evidence to suggest that the female presence in STEM fields is still lacking compared to the number of males that make up these fields. For example, in the field of Information Technology, the percentage of female presence in 1986 was at 40 percent, but at the end of 1999 had plummeted to 29 percent (McCorduck, 2005).

According to the Committee on Maximizing the Potential of Women in Academic Science and Engineering (2007) women, constituting roughly half of the total U.S. workforce and half of the degree recipients in a score of scientific fields, only make up one-fifth of the nation's scientific and technical workers. This is alarming considering the number of women who have already and are now seeking degrees and entering the workforce compared to those a few decades ago.

The research of David Beede, et. al. (2011) shows that women who have earned a STEM degree are less likely than men to enter into STEM occupations; they have a tendency to, instead, work in education or healthcare. Men, therefore, are more likely than women to have a STEM job regardless of educational attainment. Beede and his colleagues have also surmised that within the computer and math workforce (the largest of the four STEM components) the presence of women dropped three percentage points from 2000 to 2009. The lower numbers of women compared to men in such technical career areas, which are rather low, beg the question, "what is happening to deter women from joining, or staying in such careers?"

Constraints on Female Entrance and Retention in the STEM Workforce

One of the most convincing dilemmas facing women today regarding entering the study and employment of STEM fields is dissuasion. In fact, 60% of women surveyed said they experienced discouragement in college, 41% in high school, and 35% in the workplace (Nagel, 2010). Surprisingly college professors are the worst offenders of discouraging women from studying STEM. Dr. Ibram Rogers (2010) supports this research by revealing that college professors dissuade 60% of women from pursuing their interests in STEM. Nagel also concludes that other strongly dissuasive factors include colleagues, family members, advisors, teachers, and guidance counselors. Even when females do enter into STEM-based education, they find it difficult to be viewed as equal to men. It has been discovered that, in the case of postdoctoral applicants, for females to be judged as productive as their male counterparts, they need to publish three more papers in prestigious journals than men, or 20 more papers in less-known publications (Lewin, 2010).

Many women are discouraged when seeking employment with STEM organizations. Stephen Ceci and Wendy Williams (2010) found that on average, STEM organizations are more apt to hire a man than a woman, although they both have identical qualifications. Their research also shows that male and female reviewers rated resumes lower when they were made aware that the author was a woman. This is evidence of not only dissuasion, but also of discrimination. David Beede and colleagues (2011) also suggest that discrimination occurs by stating that for every dollar earned by a man in STEM, a woman earns 14% less.

Dr. Ibram Rogers (2010) argues that there is a hierarchy within STEM workplaces, with males dominating the hierarchical structure. The inherent thinking that men are more apt for STEM work has made it more difficult for women to succeed in their STEM careers. It seems that the general feeling is that men have a better comprehension than do women. This has a huge effect on the desire for women to continue in such workplaces. If a woman feels she is being underrepresented and that her strengths are not being utilized, she will eventually seek an alternate career field.

Conversely, according to Rosser and Taylor (2009), there are two primary factors, among multiple forces, pushing women to leave the STEM workforce. These include women feeling the need to balance career and family, where it seems that their career consistently takes away from family time, and a lack of professional networks. Even though the roles of women have changed in recent times, they still feel the obligation to ensure that family needs are met, thus not having the ability to balance their work life and home life in tandem. Women begin to feel burdened by the stress of attempting to balance the two, consequently leading them to seek a career that will enable them to better meet both demands. Also, a lack of professional networks takes a toll on their professional wellbeing. Having a number of professional networks allows working people to better perform their professional functions, since networks can provide much needed and useful insight. Without professional networks and home life balance, women often feel inadequate in their job.

Programs Designed to Entice Females into STEM Careers

In order to generate interest in STEM related careers, many organizations and programs attempt to engage children in STEM fields at a much younger age. These programs are occurring all across the country and sponsored by various organizations. For instance, the Austin Youth River Watch program is one in which at-risk middle and high school students participate in improving the water quality of the Colorado River. Students routinely conduct tests on water- quality, write reports to the Lower Colorado River Authority, and conduct presentations of their findings (Turner, 2001).

The U.S. Naval Academy provides a Summer STEM Camp for grades 8-11 that enhances the application of math and science principles to promote technological and engineering interests in young people (Summer Stem Camp, 2010). In this program students must demonstrate superior academic performance and accomplishment.

While many of these programs are coed, some are developed for females only. EUREKA! is a program that is part of Girls Incorporated's Operation Smart. This program runs through the summer and school year using sports and the opportunity to visit a college campus as a way to entice the girls to attend. The target audience for this program includes girls from low- income families and also girls of color. While in the program, girls are able to participate in sports activities, hands-on math, science, and computer activities, career-focused field trips, and health education (Campbell, 1995).

C-Tech, which stands for Computers and Technology, at Virginia Tech is a two-week summer camp for high school girls that introduces participants to engineering and related technologies through various hands-on activities, laboratories, and presentations. It is designed to help develop and sustain the interests of women in engineering and the science and provides opportunities to apply knowledge of these disciplines to real world situations (C-TECH2, 2010). These programs for girls combine hands-on activities, role models, mentoring, internships, and career exploration to improve self-confidence and an interest in STEM college curriculum and careers and help reduce the conceived sexist attitudes associated with the male-dominated industry (Fancsali, 2002).

Research has been performed to evaluate the effectiveness that STEM programs for young people have on furthering STEM education and ultimately leading them to enter the STEM workforce. Fancsali (2002) argues that girls show less positive attitudes toward the sciences than boys, and thus are much less likely to major in science-related college fields. Fancsali goes further to state that women are less likely to complete any undergraduate or graduate degree related to STEM. Women, therefore, as mentioned throughout this study, comprise a disproportionately low percentage of the STEM workforce.

Purpose

The purpose of this study was to determine the efficacy of the IUPUI POWER Camp in improving the perceptions of the POWER Camp participants with regards to their desire to pursue a STEM career and their perceived success in STEM fields.

In this quantitative study, the subjects were given the POWER Camp Perception Survey (Appendices A and B), which utilizes a Likert scale at the beginning of the POWER Camp session (June 19 in the first group session). At the end of the Power Camp session, (June 26 in the last group session), the survey was given a second time to the same participants.

Methodology

Design

Surveys provide the ability to quantify the attitudes and opinions of a population (Cresswell, 2009). Since the purpose of this study was to determine how much the perception of the participants changed as a result of the POWER Camp a cross-sectional survey of perception was chosen for this study.

Cross-sectional studies are studies in which all the participants are studied at the same time. A benefit to a cross-sectional study is that all the participants can be studied in a short period of time (Jackson, 2009). A cross-sectional model is appropriate for studying the perception of those attending the POWER Camp in that everyone was given the survey in a very quick fashion. In a repeated cross-sectional study, different groups are studied over time using the same methods. This method is especially beneficial when the goal is to understand how a population has changed over time (Engel & Schutt, 2005). The scope of this research was the POWER Camp of 2011.

Sample

A convenience sample is a sample in which participants are chosen in a way that is convenient to the researcher (Jackson, 2009). Every participant in the 2011 POWER Camp was surveyed since it was convenient for the researcher to administer the surveys to all in attendance, making this a convenience sample. Since all POWER Camp participants were high school age females, all those surveyed were from this same population. The population was not stratified by any criteria prior to administration of the survey. Research in a single-group pretest/posttest design makes the assumption that any changes in survey results between the pretest and posttest are the result of the treatment (Jackson, 2009). Any differences in the surveys pre- and post-POWER Camp were assumed to be a result of the participants' experiences during the POWER Camp.

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Since sixteen of the twenty-nine POWER Camp attendees submitted the required permission form, the sample size for this research was sixteen.

Instrumentation

This questionnaire was based from a survey that has been used for at least five years by Girls, Inc. to evaluate the efficacy of their girls focused STEM program (Koch, et al, 2010; Babbie, 1990). The survey was retitled "Power Camp Perception Survey" and can be found in Appendices A and B. According to Sudman and Bradburn (1982), it is useful to incorporate questions that have been used in previous surveys as these questions have already been evaluated. This results in a need for less strenuous testing and also provides greater validity to the survey. Since the questions from the original survey were modified to suit the topics addressed in the POWER Camp, validity and reliability was reviewed prior to administering the survey.

Three people in the field of technology evaluated the content validity (Litwin, 2005) of this survey to gain some external opinions as to whether or not the items presented in the survey produced the desired output. Each of the evaluators independently stated that the questions were, in their opinion, appropriate given the subject matter and audience. They also agreed that the questions presented would produce the desired output.

Survey reliability is most often evaluated by utilizing test-retest reliability. Using test-retest, a survey is generally considered to be reliable if the correlation coefficient is 0.7 or higher (Litwin, 2005). The reliability of this survey was evaluated by a group of five random people at two different times prior to the 2011 POWER Camp to ensure that the reliability of the survey instrument was acceptable. These willing test subjects were initially given the survey on May 24, 2011 and then again on June 2, 2011. Each question in the survey was evaluated separately using the Pearson product-moment correlation coefficient or Pearson's r. When both variables are measured using either an interval or ratio scale, Pearson's r is the most common measurement used to determine the correlation coefficient (Jackson, 2009). Pearson's r was evaluated for each statement in the survey. Each question was found to have a correlation coefficient between 0.70 and 1.00, which is considered reliable as previously noted when using test-retest to evaluate reliability.

The questionnaire (appendix A) was administered using a self-administered paper survey shortly after the participants' arrival at POWER Camp on Sunday, June 19, 2011 between 7:30 p.m. and 8:30 p.m. Eastern Time during the first group session of the camp and then again during the last small group session between 9:45 a.m. and 10:30 a.m. Eastern Time on June 25, 2011, the last day of the POWER Camp session (appendix B). Those open ended questions were not evaluated as part of this research.

Data Analysis

A Correlated-Groups t test was used to compare the means of related within-participants samples. The hypothesis for a Correlated-Groups t test is that there was no significant difference between the means of the two related samples, $H_0\colon \mu_1 - \mu_2 = 0$. The corresponding alternative hypothesis is that there was a significant difference in the means of the two related samples, $H_a: \mu_1 - \mu_2 > 0$ (Jackson, 2009). This results in the t test being a one-tailed t test. As the goal of this research was to determine whether or not participation within the POWER Camp affected the participants' perceptions regarding engineering, the Correlated-Groups t test was the most appropriate measure to use (Jackson, 2009).

Results

The survey given to the POWER Camp participants utilized a Likert scale to gauge the person's agreement with the statement. For all statements, a value of 5 was used to indicate that the person strongly agreed with the statement, a value of 4 was used to indicate that the person agreed with the statement, a value of 3 was used to indicate that the person was neutral with regard to the statement, a value of 2 was used to indicate that the person disagreed with the statement, and a value of 1 was used to indicate that the person strongly disagreed with the statement.

Positively Worded Statements

Table 1 shows the statements presented to the participant that were hoped to have been made more agreeable as a result of participating in the camp session. Additionally, Table 1 shows the pre-test mean, the post-test mean, the t value obtained from the Correlated-Groups t test, corresponding p value, and whether or not the change was significant based on the t value obtained. As can be seen in the table, the average values for all of the statements increased (were more agreeable) after the POWER Camp session than before the session. Utilizing the t value obtained from the Correlated-Groups t test with $\alpha = .05$ and 15 degrees of freedom, a t value obtained would need to have an absolute value greater than critical value of 1.753 in order to be significant. Based on this, only two of the statements had a significant change in value.

Table 1

Positively Worded Survey Statements

Statement	Pre Test Average	Post Test Average	t obtained	p value	Significant or Not Significant
It would be pretty fun to work in an engineering related job.	3.8125	4.1875	1.1448	0.1351	Not Significant
I know what types of classes to take in high school if I want to have a career in engineering.	3.5000	4.3750	2.9066	0.0054	Significant
Women are as successful as men in engineering careers.	4.3125	4.5000	0.6132	0.2745	Not Significant
People who work in engineering related jobs make lots of money.	3.9375	4.2500	1.4315	0.0864	Not Significant
Careers in engineering are exciting.	3.8750	4.5000	4.0379	0.0005	Significant
I would like a job related to engineering because they are challenging.	3.9375	4.1875	1.1677	0.1306	Not Significant
Women are as good as men in science and math.	4.8125	4.9375	1.4639	0.0819	Not Significant

The first positively worded statement with a significant change in value was, "I know what types of classes to take in high school if I want to have a career in engineering." This statement had an average pre-test value of 3.500 indicating slight agreement with the statement. The average post-test value for this statement was 4.3750, which indicates a much stronger agreement with the statement than during the pre-test with 15 degrees of freedom and α of .05, t(15) = 2.9066, p < .05. This is confirmation that the change in average was significant according to the Correlated-Groups t Test.

The other positively worded statement with a significant change in value between the pre-test and post-test was, “Careers in engineering are exciting.” The pre-test average for this statement was 3.8750 indicating near agreement with this statement at the beginning of the POWER Camp session. The post-test average for this statement was 4.5000 indicating more than mere agreement with the statement with 15 degrees of freedom and α of .05, t(15) = 4.0379, p < .05. This is strong confirmation that the change in average was significant for this statement.

Negatively Worded Statements
Table 2 shows the statements presented to the participant that were hoped to have been made less agreeable as a result of participating in the camp session. Additionally, Table 2 shows the pre-test mean, the post-test mean, the t value obtained from the Correlated-Groups t test, corresponding p value, and whether or not the change was significant based on the t value obtained. The average values for all but one of the statements decreased (were less agreeable) after the POWER Camp session than before the session. Utilizing the t value obtained from the Correlated-Groups t test with a = .05 and 15 degrees of freedom, a t value obtained would need to have an absolute value greater than 1.753 in order to be significant. Based on this, five of the eight statements had a significant change in value.

Table 2

Negatively Worded Survey Statements

Statement	Pre Test Average	Post Test Average	t obtained	p value	Significant or Not Significant
It is difficult for women to have successful engineering careers.	2.0625	1.2500	-2.5462	0.0112	Significant
I might be willing to try a job related to engineering, but I don't think I would like it.	2.1250	1.7500	-2.0868	0.0272	Significant
Mostly men work in engineering related jobs.	3.3125	3.8125	1.8257	0.0439	Significant
I would not like to work in an engineering job, because they are too difficult.	1.8750	1.6250	-1.2910	0.1081	Not Significant
I would not like a job related to engineering, because I do not like science or math.	1.6875	1.6250	-0.3676	0.3592	Not Significant
People with a job related to engineering have to know too much.	1.9375	1.8750	-0.2225	0.4135	Not Significant
It would be pretty boring to work in an engineering related job.	1.9375	1.6250	-1.7752	0.0481	Significant
People who work in engineering related jobs are not very cool.	1.5625	1.2500	-2.6112	0.0098	Significant

The first negatively worded statement with a significant change in value was, “It is difficult for women to have successful engineering careers.” This statement had an average pre-test value of 2.0625 indicating disagreement with the statement. The average post-test value for this statement was 1.2500, which indicates a much stronger disagreement with the statement than during the pre-test with 15 degrees of freedom and α of .05, $t(15) = -2.5462$, $p < .05$. This is confirmation that the change in average is significant according to the Correlated-Groups t Test.

The next negatively worded statement with a significant change in value was, "I might be willing to try a job related to engineering, but I don't think I would like it." This statement had an average pre-test value of 2.1250 indicating disagreement with the statement at the beginning of the camp session. The average post-test value for this statement was 1.7500 which indicates a stronger disagreement with the statement than during the pre-test with 15 degrees of freedom and α of .05, $t(15) = -2.0868$, $p < .05$. The change in average between the pre-test and post-test, therefore, was significant.

The negatively worded statement, "Mostly men work in engineering related jobs," also showed a significant change between the pre-test and post-test averages. This statement had an average pre-test value of 3.3125 indicating slight agreement with the statement at the beginning of the camp session. The average post-test value for this statement was 3.8125, which indicates a stronger agreement with the statement than during the pre-test with 15 degrees of freedom and α of .05, $t(15) = 1.8257$, $p < .05$. The change in average between the pre-test and post-test, therefore, was significant.

The negatively worded statement, "It would be pretty boring to work in an engineering related job," showed a significant change between the pre-test and post-test averages. With a pre-test average of 1.9375, the attendees disagreed with this statement at the beginning of the camp. The average post-test value for this statement was 1.6250 which indicates a stronger disagreement with the statement than during the pre-test with 15 degrees of freedom and α of .05, $t(15) = -1.7752$, $p < .05$. The change in pre-test and post-test averages, therefore, was significant.

The final negatively worded statement showing a significant change between the pre-test and the post-test was, "People who work in engineering related jobs are not very cool." With a pre-test average of 1.5625, the attendees disagreed with this statement at the beginning of the camp. The average post-test value for this statement was 1.2500 which indicates a stronger disagreement with the statement than during the pre-test with 15 degrees of freedom and α of .05, $t(15) = -2.6112$, $p < .05$. The change in pre-test and post-test averages, therefore, was significant.

Conclusion

There is an ongoing problem facing our society in which females feel unmotivated to enter into education and careers in STEM fields. Research has shown that STEM is indeed male-dominated, with only one-fifth of this workforce being comprised of women (Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2007). Although it is beneficial to have a balanced number of men and women in these careers, the trend remains that men are more apt to enter into these fields than are women.

The purpose of this study was to determine the efficacy of the IUPUI POWER Camp in improving the perceptions of the POWER Camp participants with regards to their desire to pursue a STEM career and their perceived success in STEM fields. With seven of the fifteen evaluated statements showing a significant positive change in perception amongst the POWER Camp participants, it is evident that the experiences at POWER Camp do impact the participants' perceptions regarding engineering and how women fit into engineering roles. Furthermore, of the fifteen statements, fourteen of those statements trended in the desired direction.

Summary of Results from the Study

The first survey question that deemed to be positively significant was "I know what types of classes to take in high school if I want to have a career in engineering." STEM education within schools now seems to be more important than ever before. In fact, there are many preparatory schools that have been instituted and are continuing to be instituted whose primary focus is on the sciences and mathematics. School administrators, perhaps, are now strongly persuading children to have an open interest for STEM work and are making them aware of what they need to accomplish scholastically in order to foster interest in this area. POWER Camp and other organizations like it should work in tandem with such schools and provide further information on the educational requirements needed to enter STEM careers.

At the beginning of the 2011 POWER Camp participants showed that they thought it "difficult for women to have successful engineering careers." The survey given at the end of the session, however, showed that their perception changed in a significantly positive way. If STEM programs such as Power Camp educate children about the laws and let them know that all people are equal and should be treated equally, then further positive perceptions in this area will be gained.

Another question with overall significantly positive results was the one that reads "it would be pretty boring to work in an engineering related job." Participants of POWER Camp began with preconceived ideas about such work, but upon completing the session changed this perception due to the information given them and the activities that they took part in. It seems that the organizations that helped organize the summer camp provided insight into what really occurs within such jobs. POWER Camp and similar organizations should always teach young people that the type of work they are marketing is fun and exciting.

Finally, the statement "people who work in engineering related jobs are not very cool" also showed significantly positive results. Once again, participants began the summer camp with predetermined thoughts of people in this type of field, which they changed throughout the duration of the program. During the session the participants became acquainted with people who actually have engineering careers. Upon meeting these people the participants changed their view of the people that work within this industry. It is very advantageous for STEM programs to allow participants to meet people who work in the STEM field so that they can see first-hand how interesting these professionals are and that they do not lead a dull life.

There was only one statement in the survey that showed negative results from the beginning of the session to its completion. The statement that had the negative result was

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"mostly men work in engineering related jobs." From research discussed in the Literature Review section of this study it is obvious that this statement is, in fact, true. There is nothing that STEM programs can do to change that perception since it is a fact. What STEM programs can do is inform participants that women are just as capable of performing the job as men are and that there is a necessity to equalize the gender gap within the STEM field. The education they provide should perpetuate an interest and a curiosity in young women that may help to bridge that gap.

Recommendations

It is recommended that this survey be used as a longitudinal study and given to future participants of the POWER Camp. This is especially beneficial in understanding how the perceptions of the population changed over time (Engel & Schutt, 2005). This information could prove invaluable in ensuring the program's activities remain relevant through the years. Other studies, such as a case study and open-ended surveys, could also be conducted with the purpose of finding the motives behind the participants' change of ideas over the course of the POWER Camp session.

Based on the results of the survey, it is recommended that the POWER Camp spend more of their activity time portraying women in the engineering field. It is evident that the attendees of the 2011 POWER Camp session came away from it with a stronger belief that mostly men work in engineering careers. Local companies in the engineering field organize many of the activities in the POWER Camp session and if the POWER Camp staff could recommend increased female involvement in these activities and any others on the schedule, perhaps the view that it is primarily a man's domain would not be reinforced through the course of the camp session.

The same survey should be shared with other programs geared toward encouraging young women to pursue careers in the STEM fields. Results could be shared among the programs along with the activities the programs run, who runs and coordinates those activities, how those activities are executed, and any other information. As the number of these programs sharing the results of the survey and other pertinent information increases, trends may begin to be visible. Demographic information regarding the attendees was not captured for the purposes of this study, however doing so and incorporating this information in future years may reveal further trends. Comparing the geography, family situation, or other student demographics may prove to be a key indicator of which activities could make a program successful.

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Appendix A – Pre-Camp Survey

POWER Camp Perception Survey

Name____

How much do you agree with each of the following statements? Choose one response for each statement by circling the corresponding number ranging from 5 for Strongly Agree to 1 for Strongly Disagree.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
It would be pretty fun to work in an engineering related job.	5	4	3	2	1
It is difficult for women to have successful engineering careers.	5	4	3	2	1
I might be willing to try a job related to engineering, but I don't think I would like it.	5	4	3	2	1
Mostly men work in engineering related jobs.	5	4	3	2	1
I would not like to work in an engineering job, because they are too difficult.	5	4	3	2	1
I know what types of classes to take in high school if I want to have a career in engineering.	5	4	3	2	1
Women are as successful as men in engineering careers.	5	4	3	2	1
People who work in engineering related jobs make lots of money.	5	4	3	2	1
I would not like a job related to engineering, because I do not like science or math.	5	4	3	2	1
People with a job related to engineering have to know too much.	5	4	3	2	1
Careers in engineering are exciting.	5	4	3	2	1
I would like a job related to engineering because they are challenging.	5	4	3	2	1
It would be pretty boring to work in an engineering related job.	5	4	3	2	1
People who work in engineering related jobs are not very cool.	5	4	3	2	1
Women are as good as men in science and math.	5	4	3	2	1

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Appendix B – Post-Camp Survey

POWER Camp Perception Survey

Name____

How much do you agree with each of the following statements? Choose one response for each statement by circling the corresponding number ranging from 5 for Strongly Agree to 1 for Strongly Disagree.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
It would be pretty fun to work in an engineering related job.	5	4	3	2	1
It is difficult for women to have successful engineering careers.	5	4	3	2	1
I might be willing to try a job related to engineering, but I don't think I would like it.	5	4	3	2	1
Mostly men work in engineering related jobs.	5	4	3	2	1
I would not like to work in an engineering job, because they are too difficult.	5	4	3	2	1
I know what types of classes to take in high school if I want to have a career in engineering.	5	4	3	2	1
Women are as successful as men in engineering careers.	5	4	3	2	1
People who work in engineering related jobs make lots of money.	5	4	3	2	1
I would not like a job related to engineering, because I do not like science or math.	5	4	3	2	1
People with a job related to engineering have to know too much.	5	4	3	2	1
Careers in engineering are exciting.	5	4	3	2	1
I would like a job related to engineering because they are challenging.	5	4	3	2	1
It would be pretty boring to work in an engineering related job.	5	4	3	2	1
People who work in engineering related jobs are not very cool.	5	4	3	2	1
Women are as good as men in science and math.	5	4	3	2	1

Please write your answers to the following questions:

As a student participant, what did you enjoy most about the POWER camp?

What did you least like about the camp?

Is there anything that was not included among the activities that you would like to have gotten to do?

Do you have any further comments about the POWER camp?

If you participated in the evening event, what did you enjoy most and why?

How did the POWER camp influence your decision to pursue a degree in engineering?

Appendix C – Survey Raw Data

	A		B		C		D		E		F		G		H		I		J		K		L		M		N		O		P	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
It would be pretty fun to work in an engineering related job.	5	5	5	5	5	5	3	4	3	3	4	5	3	4	4	2	4	5	3	5	3	5	4	1	3	4	4	5	3	4	5	5
It is difficult for women to have successful engineering careers.	1	1	1	1	3	2	1	1	1	1	4	1	4	1	4	1	1	1	1	1	1	1	3	2	1	2	3	1	2	2	2	1
I might be willing to try a job related to engineering, but I don't think I would like it.	1	1	1	1	2	2	3	2	2	2	1	1	2	3	3	3	3	2	2	1	2	2	2	2	3	2	1	1	4	2	2	1
Mostly men work in engineering related jobs.	2	2	2	4	5	5	4	5	4	4	4	5	3	4	3	3	3	2	3	4	4	5	2	4	4	4	4	2	2	4	4	4
I would not like to work in an engineering job, because they are too difficult.	1	1	1	1	3	2	2	2	3	3	1	1	1	3	3	3	2	1	2	1	2	1	1	1	3	2	1	1	2	2	2	1
I know what types of classes to take in high school if I want to have a career in engineering.	3	5	4	4	4	5	4	4	2	4	5	5	1	4	4	3	5	5	2	3	3	5	4	5	5	5	1	4	4	4	5	5
Women are as successful as men in engineering careers.	5	5	4	4	5	4	5	5	4	5	5	5	3	4	5	2	3	5	5	5	4	5	4	5	5	5	3	5	4	3	5	5
People who work in engineering related jobs make lots of money.	3	4	3	5	4	5	3	2	5	5	5	5	3	4	5	4	3	3	4	3	3	4	5	5	5	5	4	5	3	4	5	5
I would not like a job related to engineering, because I do not like science or math.	1	1	1	1	2	2	3	2	1	1	1	1	1	3	2	2	1	1	3	2	2	1	1	1	3	3	2	2	2	2	1	1
People with a job related to engineering have to know too much.	1	2	1	1	4	2	2	2	2	2	1	1	3	2	3	3	2	2	2	1	2	1	2	1	1	4	2	3	2	2	1	1
Careers in engineering are exciting.	4	5	4	5	5	5	3	5	3	4	5	5	3	3	3	3	4	5	4	5	4	5	5	5	3	3	4	5	3	4	5	5
I would like a job related to engineering because they are challenging.	4	5	5	5	4	4	4	4	3	4	4	5	4	3	3	1	4	5	4	5	4	4	5	5	3	4	4	4	3	4	5	5
It would be pretty boring to work in an engineering related job.	1	1	2	1	2	1	2	2	2	2	1	1	3	3	2	3	2	2	2	1	2	2	2	1	1	2	2	1	3	2	2	1
People who work in engineering related jobs are not very cool.	1	1	1	1	1	1	1	1	3	2	2	1	2	1	3	3	2	1	1	1	1	1	1	1	1	1	2	1	2	2	1	1
Women are as good as men in science and math.	5	5	5	5	5	5	5	5	5	5	5	5	4	4	5	5	5	5	5	5	5	5	5	5	5	5	4	5	4	5	5	5

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Enhancing Popular Problem-Solving Projects: Chair Design Activity

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Abstract

Problem-solving activities are popular and potentially high value learning exercises when well designed and executed. Many of these types of activities are highly competitive and use open-ended goals that are difficult to determine the level of quality until well after the activity is completed and comparisons between student outcomes are made. These two factors combined can reduce the learning value for many students since the benchmark of quality is only determined after the activity is completed. By establishing measurable benchmarks that can be recognized as quality before the activity begins, many students will be more motivated to reach the desired or required objectives. This work explores ideas for reducing the negative impacts of open-ended goals that can only be accurately evaluated after an activity ends, by making it possible for students to recognize the quality of their results prior to submitting final projects for review. The ideas shared in this example can be transferred to a wide range of problem-solving activities that could benefit from the recommended improvements to objectives used for these types of educational activities.

Introduction

Learning through problem-solving is a popular educational strategy. This method is common in science, technology, career and technical programs, and others. Cotton and Calkins (2011) reported, "Problem-solving activities let students use knowledge gained in various areas of their academic education. They help bring together skills and knowledge from such areas as science, math, art, and English by simulating activities and projects students will encounter later in career and life experiences" (p.24). Problem-solving activities provide students with realistic experiences. This approach helps students recognize how a variety of skills and knowledge acquired in different subjects are applied in their lives. There are many popular and commonly used design projects today which teachers have modified for a variety of objectives and audiences. It is important to ensure that the expected outcome stated is clear, concise, measurable, and objective (Cotton, S., & Calkins, C, 2011).

The purpose of this work is to help instructors make problem-solving activities more effective. One weakness in many popular problem-solving projects is objectives that can only be evaluated by comparison with other student outcomes. In a common project type, students design products to carry loads, like a bridge or chair. A common required goal is to make the strongest product. Because strongest can't be determined until all projects are completed there is little evidence that these designs were adequate until it is too late to revise. When a student knows an objective precisely, the objective can be measured for success prior to completion, increasing motivation because success can be recognized prior to comparison to other products. This is also realistic to real world designs. An engineer does not design a bridge to be as strong as possible because overdesign is costly and often prohibitive. Normally the load that a structure must support is determined prior to starting the design phase. Only then is the structure designed to support that design load. A product can be tested for design load but a "strongest" goal becomes a competition which impedes some students from engaging because of a feeling of inequality compared to abilities of other students. Also, competition generally requires comparisons to recognize quality or success. Some students are difficult to motivate when they do not clearly understand the goal and how to recognize their work is high quality prior to comparisons with others.

In an educational environment, students participating in a competitive design that does not provide a specific outcome may actually experience reduced motivation. Since “successful design” under these conditions cannot be recognized until after it is too late to make revisions, students often submit first designs as final products hoping they will be adequate. Providing outcomes that can be recognized as successful prior to testing will encourage students to experiment. For example, a design outcome that requires a product to support between 150 and 250 pounds is testable during the development process. A required outcome of making a product as strong as possible allows little control over what adequate is and is not realistic to real structural design objectives.

This work proposes a structural design activity that is similar to projects that many instructors have used in the classroom. It will then explore ideas for improving the learning outcomes by making them less open-ended so that students can recognize the quality of their results prior to submitting their product for evaluation. The discussion will also explore strategies for executing and assessing the activity.

Simulating Reality

This project is designed to be very similar to the process that a designer in the corrugated paper industry would experience. Projects like this chair design activity can be beneficial for students who are looking to become Industrial Designers, or are interested in occupations within a production and manufacturing environment. Industrial Designers and manufacturers incorporate all aspects of art, business, and engineering to construct products that people use every day (Bureau of Labor Statistics, 2014-15). For students wanting to continue in this direction, successful completion of the chair design activity will better prepare them for industrial design positions, and improve manufacturing skills.

Since many corrugated products, such as store displays, are structural in nature and often do not use adhesives for assembly; this product will use this same design parameter. Many corrugated products, other than sealed packaging used for shipping, require user assembly, so this is also a design parameter suggested for this project. One universal principle in producing products for the general public is the lack of control over the characteristics of the purchaser/user. This is simulated in this project by the lack of control over the size and skill of the person who will be assembling the product.

The time period indicated in the design brief is very general so the instructor can adjust this to meet the needs of each class/instructor. Three weeks is suggested as an appropriate time requirement, but more or less may be used depending on how much time per day and how many days per week are allowed. Another time factor to consider is whether the students will be expected to work on this project outside of class time.

An interesting and realistic approach to some problem-solving activities is to restrict the materials used and/or time available (Cotton, S.E., 2002). A good example of replicating real situations is the Apollo 13 experience of experiencing a problem, which had to be resolved only with materials on board the capsule and within the time remaining for oxygen supply after an onboard explosion. It is recommended that materials for this project be very restrictive, and consist of only single strength corrugated paper. As with any assembly, clear instructions are needed to guide the person assembling the product. This is a valuable opportunity for students to experience the impact of poor written language skills, by seeing how poor grammar, spelling, word choice, and punctuation can confuse readers who require the written word to accomplish a complex task. Since there is limited control over the purchaser's ability to read, it is critical that instructions are not restricted to text only, since quality graphics is another important communication tool.

Since the primary objective of the project is to develop a portable and easily assembled chair of corrugated paper, there is a size limit. The product simulates a marketable product, not a prototype, so the product must be clean and appealing. One cannot control the size of the customer, but it would be reasonable to identify a maximum design weight which would be indicated on the product and in the instructions.

Selecting test "customers" and load testing

There are several methods that may be used to select sample customers, but it is suggested that some type of random selection be used to prevent the preparation of the person assembling the product and to add equity to the selection from a varied population. This may be as simple as inviting another class to be the testers without advance notification of the participation.

The product can be load tested by either the person doing the assembling or another selected individual. It is advisable to have the tester, for a short period, lift their feet to eliminate the chance of not fully loading the product. An alternative would be to have a randomly selected dead weight load placed on the product to decrease the safety concern regarding a product that fails the load test. This could be accomplished with blocks, bricks, or other weights. When using dead weight, it is suggested to vary the load used by random drawing to simulate the varied weights of users.

Evaluation

In this example there are ten different product measures used for evaluation, each of which accounts for 10 percent of the total score (see "Assessment Worksheet"). Knowing how the project will be scored, students will be able to determine the potential impact of concentrating on any particular facet of the design. This helps overcome the negative affects of a student perceived weakness on any single design goal, whether it be artistic, quality control, structural soundness, etc. It is important to note that students also learn from mistakes, so a failed effort in any single measure factor, does not result in a perception of being significantly disadvantaged, which will help encourage students to concentrate on strengths instead of giving up because of perceived weaknesses in one of the skills required.

Note that 60% of the evaluation results from objective observations are from an independent observer and not the instructor. By using an independent observer for the objective observations made during the testing, it becomes possible to assemble several products at one time and allows the instructor to monitor the process. The observers record the findings/observations using the checklist provided. Only the final 40% of the evaluation process involves subjective measures normally determined by the instructor after testing. It is recommended that the instructor devise a rubric or other informative document that will explain to the student how the subjective portion will be evaluated. This should contain enough detail that the student will be able to accurately anticipate the outcome of this part of the evaluation. This subjective measure is not included in this example because a subjective measure is largely determined by the personality, teaching style, and priorities of each individual instructor.

Draft Example

Below is a general guide for what types of items can be included in the student instructions handout. This has been presented in brief, so that the teacher can add and customize information to the activity in order to fit his/her particular purposes. Teachers can incorporate different safety practices to the instructions like making sure students do not cut corrugated paper directly on work surfaces. Teachers can also take necessary precautions and use scrap material to protect working surfaces. Other basic instructions include a detailed timeline for the project goals and due dates, as well as information detailing how the product will be constructed.

Let’s Take it Easy!
Chair Design – Usability Study
Camping/Fishing Chair Product Study

This project is intended to give the student exposure to studying the usability of a simple product design and the assembly instructions for that product. The product will target the general population with the concept that it would be marketed through department stores with little control over the end purchaser. It may be desirable to identify a maximum weight the product will support, as is the case in most load bearing products in real product design. It is suggested to use 300 plus or minus 50 pounds. The student will create a product according to guidelines provided in this document and then will use a random sample experimental study to test the usability of the product and supporting documentation.

Materials and other information

Teachers should be sure to detail what kinds of materials will be used. This example guide assumes that students will be using only single strength corrugated paper. Each student will prepare the product components, a company name and logo, and a set of instructions for assembly. See figures 1 and 2 for an example chair with no fasteners or other enhancements. Note the securing strap used in place of glue or tape in figure 2.

Instructions should be on plain, letter-size paper. No parts of the product should be preassembled; only precut, pre-marked, or pre-scored parts of single strength corrugated paper may be provided. Note this is also an opportunity to help student recognize the difference between corrugated paper and cardboard, with cardboard actually being a solid stock with no corrugation. The students must create instructions that contain both written and graphic information. The instructor should determine whether graphics are limited to photos, drawings, or a combination of the two based on the skills set to be experiences in the specific program involved. The person testing the product should not have any prior knowledge of the product or the instructions. The finished product will be evaluated on ability to carry design load, logo design, assembly success and appearance, quality of instructions, and product appearance.

Figure 1 - assembled example

Figure 2 - Interior Structure

Parameters of Product

1) The product is a camping/fishing type chair, which can be transported and disassembled.
2) The assembled chair must be no larger than an 18” cube, with a seating surface no lower than 16”.
3) The chair must include a minimum of 6 separate components/parts requiring assembly.
4) Each part may be pre-cut to shape and include appropriate markings or scoring.
5) At least one page of assembly, step-by-step instructions must be provided.
6) A company name must be provided along with a logo.
7) The assembled product must be capable of supporting the maximum weight.
8) The student should not be permitted to assist the person assembling the product.
9) The product will be tested for strength after assembly is completed.

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Testing Suggestions
The product should be tested by a third party who is not familiar with the designer or the product. Evaluators will observe the testing procedure and complete an objective list of observations to serve as input for the final evaluation (by the instructor). The "customer" will be provided with a packaged product and allowed to review the parts list to confirm that all parts are included and to sort the parts for quick access. The person assembling the product will then be allowed to open the instructions and attempt assembly of the product. The assembly will be timed and this will be factored into the assessment of the activity. Ease of assembly and clarity of instructions are important factors in the design of this product.

After successfully (or unsuccessfully) assembling the product, the product will then be load tested for reliability of performance. The test will require a person to sit on the product for a minimum of 20 seconds without product failure, followed by an additional 10 seconds with feet raised off the ground to insure full loading occurs. An alternate testing procedure will require the product to support a randomly selected dead weight for 30 seconds. If dead weight is used, care should be taken to load evenly with no pressure well off center to avoid torque failure. See figure 3 for example of dead weight used to test product strength.

Reminder: The designer cannot directly or indirectly assist in assembly in any way.

Figure 3 - Example loading

Assessment
Factors included in the final assessment of this activity will include the following:
(see figure 4 - example evaluation form)

- All required materials submitted properly and on time.
- Appearance and completeness of instructions and parts list.
- Appearance, placement, and proper development of the company name and logo.
- Time required for constructing the product (when the "customer" feels it is completed). [This factor will be based on the final range of times required]

- Whether the product meets all design parameters (size limits, required documentation, material limitations, etc.).
- Whether the product was successfully (or sufficiently) completed without interference of the student designer or from any other outside source (other visitors).
- Appearance and desirability of the final product.
- Performance on the load test. [Any failures will be in part evaluated based on the final time to failure]
- Apparent reusability (durability) of the product. (Was the product destroyed or damaged beyond reuse during the load testing)
- Originality of the project. (If a product is very similar to another in class, then it will not be deemed "original" so protect your designs from the other class members. Commercial espionage can be damaging to any manufacturer.

Special Notes

1) Any damage to laboratory work surfaces (example: cutting work surfaces with a matt knife) may result in serious deductions in scores.
2) Be sure to submit each item required by the dates noted in timeline, including the draft proposal. Waiting too long will almost certainly have negative impacts on the quality of the product and the instructions.
3) The student must provide the materials for the project, so it will be essential to get an early start on obtaining the materials. Many local merchants dispose of large quantities of corrugated boxes daily, this is a good starting point. Also, many merchants sell storage or moving boxes or stock corrugated paper sheets.
4) It would be advisable to experiment with designs and test a design prior to submitting, although this will not be a consideration in the assessment since there is no tool available to confirm this.
5) Design hint: In additions to your own testing of the product during design and development, have a friend try to construct and test the product using the current instructions prior to submitting the product for assessment. Note: This should not be the person brought to class to assist in testing since they should not be familiar with the product. The product should go through many revisions based on these tests.

(The timeline noted above must be established by the instructor based on time available for the activity and any modifications made to the basic model discussed and clearly documented for student reference.)

Draft Assessment Form

Let's Take it Easy! -- Assessment Worksheet

Student Name:______________________________________ Project #_____________

Observer checklist:

1) All required materials submitted properly and on time (2 points each possible):
- ☐ Chair in disassembled condition
- ☐ Product in closed package
- ☐ Parts list included on separate page than instructions
- ☐ Instructions included
- ☐ Logo on project/documentation and name submitted materials

(Special notes for above: ____)

2)	Was the project successfully completed by "customer"?	☐ yes ☐ no
	Any interference or assistance by designer or others?	☐ yes ☐ no
	How many times? **(Circle)**	**1 2 3 4 5 +**
3)	Time required to complete assembly?	**Minutes**____ **Seconds**____
4)	Does the project meet design parameters?	☐ yes ☐ no
	Seating surface between 16" and 18"?	☐ yes ☐ no
	Tape, glue (adhesive), fasteners used?	☐ yes ☐ no
	Only single strength corrugated paper used?	☐ yes ☐ no
5)	Passed dead weight load test?	☐ yes ☐ no
	If not, how long did the product support the load?	**Seconds**______
	Successfully passed full load test. (if applicable)	☐ yes ☐ no
	If not, how long did the product support the load?	**Seconds**______
6)	Does product appear to be reusable?	☐ yes ☐ no
	Condition appears to be **(circle)**	**Poor Fair Good Excellent**

NOTE: The following to be completed by instructor only:

7)	Appearance and desirability of product.	______
8)	Originality of product and instructions.	______
9)	Appearance and apparent effectiveness of instructions.	______
10)	Appearance, placement, and development of logo.	______
Total Score		______

Figure 4 – Example evaluation form

Conclusion

There are many very good problem-solving projects in common use today with many new projects being continually introduced, but many use objectives that are too open-ended to encourage high student motivation to do quality work. This work attempted to offer strategies for creating more powerful and useful objectives for problem-solving instructional activities. Many problem-solving activities can be located through simple Internet searches. With minor adjustments to many of these already effective and proven projects, it is possible to refine them further and create even more valuable learning activities. By making end results observable, specific, and objectively measurable; student performance and motivation can be enhanced because when the objective is vague or not measurable students don't recognize success and may lower their own expectations. A clear target is important as a motivator for effort and direction in a design challenge. These minor changes make the objectives of problem-solving activities more overt and thereby help students better understand what is expected, helping them recognize when they have met or exceeded expectations without waiting until after the outcome or product is tested.

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Integrating Variable Data Printing in the Career and Technical Education Classroom

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Abstract
Variable Data Printing (VDP) is transforming the field of graphic communications, and therefore career and technical educators and technology educators should become aware of it. The purpose of this article is to inform educators about the definition and development of VDP, rewards and potential drawbacks of VDP, the need to teach about VDP, the popularity of VDP, and examples of how it is currently being used. Once educators have an understanding of this technology, decisions regarding implementing it in the curriculum can be considered. While it may not be economically feasible for some school districts to invest in VDP, educators should learn more about VDP so that they can collect samples of items that have been printed with VDP. These samples can be shared with students to increase awareness of this advancing technology.

Introduction

Variable Data Printing allows a printer to produce personalized content on a printed piece. One such example that most educators could collect and share with their students is a phone bill. A phone bill is printed with VDP and includes unique information such as the consumers name, address, bill cycle, account number, minutes used, data used, and the bill. **See Figure 1** for an example of a phone bill that was printed with VDP.

Figure 1

at&t

EDWARD J. LAZAROS
4319 W CLARA LN # 170
MUNCIE, IN 47304-5470

Page: 2 of 3
Bill Cycle Date: 08/29/12 - 09/28/12
Account:
Foundation Account:

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EDWARD J. LAZAROS

Other Charges and Credits

Voice Usage Summary	
Nation Unlimited	
Daytime Minutes	
Minutes Used	2,799
Night & Weekend Minutes	
Minutes Used	936
Data Usage Summary	
Messaging Unlimited	Unlimited
Used	2,402
Data Unlimited	
Plan KB	Unlimited
KB Used	366,263

1 Gigabyte (GB) = 1024MB, 1 Megabyte (MB) = 1024KB

Surcharges and Other Fees	
6. Federal Universal Service Charge	3.27
7. Indiana Universal Service	0.26
8. Regulatory Cost Recovery Charge	0.29
9. State Gross Receipts Surcharge	1.31
10. Telecom Relay Service Fund	0.03
Total Surcharges and Other Fees	5.16
Government Fees and Taxes	
11. 9-1-1 Service Fee	0.90
12. IN State Telecom Tax	6.64
Total Government Fees and Taxes	7.54
Total Other Charges & Credits	**12.70**
Total for 765 215-7498	**128.19**
Total for Wireless accounts	**128.19**

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ELECTRONIC CHECK CONVERSION
Paying by check authorizes AT&T to use the information from your check to make a one-time electronic fund transfer from your account. Funds may be withdrawn from your account as soon as the same day your payment is received. If we cannot process the transaction electronically, you authorize AT&T

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VDP affects the lives of countless consumers without them even knowing that the technology existed. Indiana Ticket Company in Muncie, Indiana uses VDP technology and produces tickets with individualized ticket numbering. **See Figure 2** for an example of tickets that have received individualized numbering. Educators could collect samples of tickets from professional sporting events and share these with students during discussions about how VDP technology works. According to Alexander (2004), "variable-data printing involves the creation of an initial, unfinished document (the template) to which variable information (text or images) can be added at specific locations to create finished, print ready documents in more than one version" (p. 3). According to Bennett, Levenson, & Romano (2006), "VDP is simply the ability to vary data from page to page" (p. 3). VDP makes it possible to print content that is unique and relevant to each individual. Unlike typical mass mail marketing, VDP has the potential to reduce the volume of mail produced by direct mail marketing. With rising costs in shipping and postal rates, this new technology becomes an attractive option for modern print providers. Educators need to immerse themselves in the development, use, and integration techniques for VDP in the classroom.

Figure 2

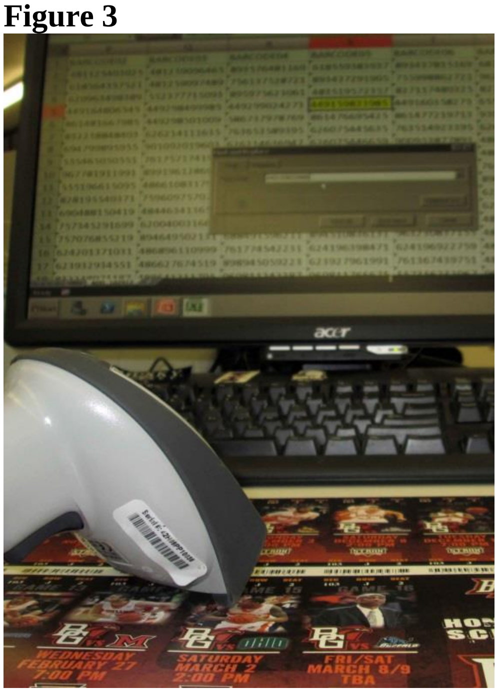
VDP Development

The development of VDP has been a long process. In a primitive form, VDP has been around for many years. With the introduction of personal computers in the early 1980s, Microsoft Office provided the function of mail merge. This allowed printing a client's name over a traditionally printed piece (Bennett, et al., 2006, p. 3). VDP came into being in the early 1990s with the rise of printers such as Xeikon, Indigo, NexPress, and Xerox. Most of these printers were limited to monochrome dot-matrix products. Throughout the 1990's, developers continued providing higher- and higher-quality color laser printing. Cheaper color printing has increased the use of VDP (Wolfe, 2003, p. 14).

One of the challenges of VDP relates to file size. Since every page in a typical VDP document is unique, VDP documents can contain hundreds or thousands of pages, depending on the size of the job. This leads to the problem of potentially huge file sizes, which can slow down a printer's workflow. One of the keys to solving this problem has been file formats developed specifically to reuse common objects. For example, a VDP job may have 2,000 unique pages, but all of the pages share the same images. File formats have been developed that can reuse those common images, thus reducing the overall size of the file drastically. However, there are numerous file formats or "languages" currently in use for VDP, which makes the digital world of VDP a very complex one (Harper, 2007, p. 1-2).

In 1999, developers started a commission to establish standard specifications for variable data printing. The PODI (Print on Demand Initiative) designed PPML (Personalized Print Markup Language). PPML, based on XML (Extensible Markup Language), was initially too restrictive. Another commission shifted PPML's focus to PDF printing (Alexander, 2004, p. 24). The present forms of PPML are PPML/VDX and PPML/GA. VDX (Variable Data Exchange) is designed for projects without a known printing system. GA (Graphic Arts), on the other hand, is very similar to the proprietary versions of PPML. PPML/GA has a wider adoption rate among many printing companies. Although its growth has been slow and steady, VDP continues to secure a niche for itself in the digital printing market.

Using a Database
The heart of the VDP process is a robust database. **See Figure 3** for an example of what a robust database looks like.

Figure 3


Once data is obtained for use in a database, it must be used wisely to be effective. Kate Dunn, the president and owner of Digital Innovations Group, says:

> For example, you might buy a list that tells you whether someone is married or single. However, you are not going to send out a piece that says, "John, you're single, so you might be interested in this…" Instead, you'll say, this group is all single people, so we will use this picture and this messaging. This group is all married people, so we will use that picture and that messaging." Married or single is what the database says. You have to extrapolate how you want to use data for marketing (Tolliver-Nigro, 2010, p. 12).

Information held within a database, such as a client's name and address, is easily assigned to individual printed pieces. Current changes in software and the advancements in digital printing have allowed extensive options with variable data. Options extend well beyond the transitional monochrome designs to full color. According to Alexander (2004), "Several of the categories that had been predominantly monochrome (or monochrome with a single spot color) are now starting to see demand for color" (p. 4).

Available VDP Software
A variety of different VDP products are currently on the market. These include:

- EZ-Letter (ABA, Inc., www.accessaba.com). EZ-Letter is used to generate labels for direct mail.
- FormScape (Bottomline Technologies, www.bottomline.com). FormScape is used for generating reports, invoices, and labels
- Bdoc Suite (Business Documents, www.bdoc.com). Bdoc Suite is used to create long and complex documents like insurance policies.
- Darwin Desktop (Creo Color Servers, www.creo.com). Darwin Desktop is used to create very long documents such as personalized catalogs.
- HP Exstream (HP, www.hp.com). HP Exstream generates marketing materials and business documents such as statements.
- XMPie (Xerox, www.xmpie.com). XMPie, like Darwin, is a sophisticated VDP software that allows for extensive personalization of text, design, and images (Alexander, 2004).

Tough Transition to VDP
The rewards of VDP and digital print are evident; however, as a concept, VDP has been difficult to sell to the printing industry. Many printers have indicated that the concept is too new to grasp, there is not enough data to support the extensive VDP options, and digital printing equipment can be expensive. There are also confidentiality concerns, and not enough time to learn or implement the VDP process (Farquharson, 2007, p. 36).

The transition from the analog print and the traditional mail marketing is not easy. Careful planning is required to make this a smooth transition. The individual steps within the graphic communication workflow require a reevaluation when working with variable data. However, through these challenges come opportunities for individuals and organizations. The challenge is to harness this potential and provide variations in print that are beneficial to the print buyer. To be able to utilize the functions of VDP, the graphic communications firm must have access to information that relates to clients they intend to target. **See Figure 4** which illustrates how information about clients on the right screen is used when assigning tickets for a sporting event on the left screen.

Figure 4

Those in the graphics industry should make sure there is a need for VDP services prior to making the investment. Farquharson (2007) encourages printers to communicate with their customers to determine their needs related to VDP output. If the customers express considerable interest, there may be enough demand to make the investment in this new technology. Printing variable data jobs has become easier than ever before. **See Figure 5** for an example of a modern press being used to print a variable data job. Web-based clients currently provide intuitive systems for designing custom templates. Businesses can offer free PDF previews of a customer's project before providing a quote. Many have enabled one-click ordering systems (Felici & Alexander, 2004). Support for XML and other data formats are increasing in prominence.

Figure 5.

The popularity and feasibility of VDP seems poised to continue to advance. According to Romano (2004), "We expect that more complex jobs will call for intermediation by the printer, who will generate new profits through database and related services" (p. 22). Some analysts have contemplated the pros and cons of a company simply printing its own advertisements, rather than approaching a firm. "…Variable data tools and digital printers are becoming so easy to use that a business can create its own professional-looking variable data print jobs in pursuit of an internal corporate goal" (Lenatti, 2008, pg. 14).

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Examples of VDP Systems

Political campaigns are experimenting with independent VDP. VDP is perfect for customized mass-mailers. To test this, one Democratic campaign group purchased their own printers, and produced between 400,000 and 500,000 mailers a day for a small local campaign (D'Aprile, 2009, p. 14). With these personalized mailers came a tenfold surge in response rates. This surge came at a cost; the price for a single traditionally-printed mailer hovers around ten cents. The price for a VDP mailer is around four dollars (D'Aprile, 2009, p.15).

Although all types of VDP systems on the market share the concept of a template where content can be added, their implementation varies. Transaction printing is among those that use a page layout approach to determine where boundaries for information will be. The software has rules for determining where page boundaries should be positioned and for how long a document should be. Typically, billing documents are unpredictable in terms of length, so a page layout approach would not be feasible and software with rules for determining page boundaries would be more appropriate (Alexander, 2004, p. 5). Due to this, invoices and bills are often generated using a VDP process.

Other examples of easily-ignored products that have the potential to be more successful with VDP include direct mail messages indicating that you may have "already won." While these systems have been the mainstay for many years, their lack of color has easily identified them as junk mail, thus providing the client with limited success. Savvy businesses are putting pressure on print providers for improved appearance and quality. **See Figure 6** which illustrates an individual checking the quality of color for a print job to guarantee outstanding appearance and quality. Businesses are demanding better designs, more color, and a higher return on their investment. Fortunately, digital color printing is becoming more economical and practical for large print jobs (Alexander, 2004, p. 3).

Figure 6

Large firms with enough capital have caught on to the VDP revolution as well. General Motors experimented with VDP by mailing three million personalized advertisements. A New York university mailed several thousand custom mailers to prospective students, advertising many sports and activities specifically selected for the recipient. Basic information is often contained in a customer database; from that information, more detailed information can be extrapolated (Lenatti, 2008, pg. 15). Data used in these campaigns was largely drawn from Internet sources. Although the cost of data management, printing, and prepress are still high, firms argue overall marketing costs are lessened by VDP (Schmidt, 2000, p.13). Rather than sending out a vast quantity of anonymous mailers, companies can send out smaller quantities of personalized mailers and hopefully receive a greater return on investment.

Conclusion

It remains to be seen whether or not VDP will become common in political campaigns and businesses, but its growing presence is undeniable. The field of graphic communications is going to continue to evolve as VDP transforms printed products. With such a wide variety of applications, educators should be aware of this evolution and begin to teach students about VDP and its future potential in the industry. Educators should consider gathering VDP printed samples to share with students and working toward the procurement and integration of VDP technology in career and technical education and technology education classrooms and laboratories if economically feasible.

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