INSTITUTE FOR
Learning Innovation

EdHeads

Motorola Cell Phone Design

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The Institute for Learning Innovation

As part of the requirements of a grant from Motorola, Edheads contracted with researchers for the Institute for Learning Innovation (ILI) to evaluate the online experience Motorola Cell Phone Design project which focused on engineering design and in particular enhancing the interest of middle school aged females in pursuing careers related to engineering. The following report contains the results of a pre-post summative measure conducted with participants who completed the online experience.

Method

In order to gather data from students who participated in the online program a web based survey was administered prior to participation in the program and again upon completion of the program. The study was established in collaboration with a local school district where the measures and activities occurred during the conduction of a regular class. A total of 162 students completed the pre-program web-based questionnaire while 141 participants took part in the post program measure.

The pre-measure consisted of 6 questions designed to measure the students' knowledge of engineered design and the process of engineered design with the last question having five potential answers. The post program questionnaire consisted of the same 6 questions so that knowledge change could be measured along with scaled questions to measure participants'

perceptions of engineering as a career and perceptions of the features of the web based experience (See appendix A).

Results

Data from the web-based questionnaires were analyzed for the central tendencies of each question, item and scale means, and cross tabulated to identify statistically significant difference between the responses of boys and females.

Knowledge Questions

Subjects were given the same 6 questions both before and after participating in the program. Five of the questions were multiple selection with one answer being correct. The sixth question asked participants to describe the process of creating a product using engineered design. The sixth question was scored based on the number of correct components that the participants included in their answer. Therefore a student who mentioned three of the components correctly would NOT have gotten the answer fully correct, however they would have been awarded 3 points towards their overall score for the portion they answered correctly. Table A below shows the percent of students who answered each of the 5 multiple choice questions and the short answer question correctly on the pre program survey, the percent of participants who answered each of the 6 questions correctly on the post survey, and the percent change from pre to post.

Table A

Question	Correct Answer	% correct Pre	% correct Post	Difference (Post – Pre)
What makes something engineered design rather than art?	It has purpose.	37.9%	69.8%	+31.9%
Who is involved in the engineering process?	Many different people.	50.3%	44.6%	-5.7%
The primary key elements of engineering design success are?	Meeting the needs of the client and users.	57.8%	82%	+24.2%
Good engineering design is meant to do what?	Solve a problem.	50.6%	69.1%	+18.5%
Which of the following statements is best for engineering design?	Potential users tell engineers what the design should do.	29.8%	52.2%	+22.4%
If you were asked to design a new type of chair for middle-school students, what would you do? What steps would	Research-Design-Test-Redesign-Present	.6%	8.6%	+8%

you follow?				

Table A: Correct knowledge responses by percent

Overall the mean number of questions that students answered correctly on the pre-test per student was: **5.12/10** questions answered correctly. On the post-test the overall mean correct **increased by 1.98 to 7.10/10** questions answered correctly.

The difference between total number of questions answered correctly pre program versus total number answered correctly post program were analyzed to determine if the difference between pre (Mean=5.12) and post (Mean=7.10) was statistically significant. Due to the nature of the data collected, an independent sample t-test was run which determined that the differences between the pre and post scores was significantly different at p=.000. This suggests that participation in the program led to a statistically significant increase in the knowledge scores of students who participated in this study.

Knowledge gain males compared to females

The differences between scores in knowledge were then analyzed based on the status of male compared to female. Table B shows the differences between males and females on total correct answers for the **pre-test** students.

# of males – 76 (47.2%)
# of females – 85 (52.8%)

Question	Correct Answer	% correct males	% correct females	Difference (Males – Females)
What makes something engineered design rather than art?	It has purpose.	31.6%	43.5%	-11.9%
Who is involved in the engineering process?	Many different people.	51.1%	49.4%	1.7%
The primary key elements of engineering design success are?	Meeting the needs of the client and users.	55%	60%	-5%
Good engineering design is meant to do what?	Solve a problem.	52.6%	48%	+4.6%
Which of the following statements is best for engineering design?	Potential users tell engineers what the design should do.	27.6%	31.7%	-4.1%
If you were asked to design a new type of chair for middle-school	Research-Design-Test-Redesign-	0%	1.2%	-1.2%

students, what would you do? What steps would you follow?	Present			

Table B: Pre-test correct responses by percent and sex

For males, the mean overall score for the knowledge questions on the pre-test was 4.63 questions answered correctly. For females, the mean overall score for the knowledge questions on the pre-test was 5.55 questions answered correctly.

A crosstabs analysis was run on the differences between the overall pre-program knowledge scores of males compared with females. Using an independent sample t-test, the differences between overall pre-program knowledge scores of males and females was found to be statistically significant at p=.026. Of note, this difference is significant, and females had the higher pre-program score.

Post Test Analysis

The differences between scores in knowledge were then analyzed based on the status of male compared to female. Table C shows the differences between males and females on total correct answers for the **post-test** students.

# of males – 76 (47.2%)
# of females – 85 (52.8%)

Question	Correct Answer	% correct males	% correct females	Difference (Males – Females)
What makes something engineered design rather than art?	It has purpose.	63%	75%	-12%
Who is involved in the engineering process?	Many different people.	42%	46.9%	-4.9%
The primary key elements of engineering design success are?	Meeting the needs of the client and users.	80.7%	82.7%	-2%
Good engineering design is meant to do what?	Solve a problem.	70.2%	69.1%	+1.1%
Which of the following statements is best for engineering design?	Potential users tell engineers what the design should do.	43.9%	58%	-14.1%
If you were asked to design a new type of chair for middle-school	Research-Design-Test-Redesign-	5.3%	11.2%	-5.9%

students, what would you do? What steps would you follow?	Present			

Table C: Post-test correct responses by percent and sex

The overall mean for correct answers by males on the post-test was 7.0/10 correct answers. The overall mean for correct answers by females on the post-test was 7.2/10.

An independent samples t-test was run on the data comparing the total correct scores of males with females. The test showed that the differences between males and females scores post program was not statistically significant. It should be noted that females started with a slightly higher knowledge score and ended with an almost equal score suggesting males had overall a greater gain.

Knowledge gains based on gender

As noted above both male and female participants demonstrated knowledge gain from pre to post program. Also, overall the knowledge gain was significant. The knowledge gain from pre to post was then analyzed based on gender using an independent samples t-test. This procedure tests the null hypothesis which would state: the knowledge change demonstrated by males from pre to post-program is not significant; and the statement: the knowledge change demonstrated by females from pre to post-program is not significant. The results of the independent samples t-test show that:

The difference between males pre-program mean score (4.63) and post-program mean score (7.0) is statistically significant at p=.000.
The difference between the females pre-program mean score (5.55) and post- program mean scores (7.2) is statistically significant at p=.002.

Both male and female participants in the program demonstrated significantly different mean scores after completing the program.

Agreement Scales

For the post-program measure, participants were also asked to state on a scale of 1 to 7 (with 1 being strongly disagree and 1 being strongly agree) how much they agreed or disagreed with statements related to their interest in engineering and their likelihood to pursue future careers involving engineering. Table D shown below lists each item that students were asked to state their level of agreement, the mean score for each item, the mean score for female participants and the mean score for male participants. The table also shows the results of an independent samples t-test run on each question comparing male and female scores.

Statement	Overall Mean	Girl Mean Score	Boy Mean	Statistically

	Score		Score	Sig P value.
Engineering is important in my daily life	5.27	4.93	5.75	p=.004
I use engineered products all of the time	5.87	5.93	5.77	
I could become an engineer if I wanted to	4.61	4.22	5.19	p=.005
I can see myself in an engineering related career	4.07	3.51	4.86	p<.000
I can see myself as an engineer	3.49	2.85	4.40	p<.000

Table D: Mean scores on engineering focus

The above table reflects that after the program female participants agreed with the statements at a lower level for all statements with the exception of "I use engineered products all of the time." Interestingly this is the only statement in which the difference between the scores is not statistically significant. Males rated their agreement higher for the other four statements and the difference between scores for females and males on each of these four items was found to be statistically significant.
There is a consistent decline in mean scores overall and for both males and females as the statements increase in future commitment toward engineering. Use of products is stronger than perception of being able to become an engineer which is stronger than being in a related career which is much stronger (and slightly negative for females) than seeing self as an engineer. Females clearly disagree overall about seeing themselves as engineers while males are slightly positive.

Features of the online program

The post-program measure also asked participants to rate from 1 – 7 how strongly they agreed or disagreed with statements regarding various features of the online program (1 being strongly disagree and 7 being strongly agree). Table E shows the statement, the mean overall score, the mean score given by females, and the mean score given by males. The final column of the chart also reflects whether the difference between female and male scores was significant and what the P value was for the significant items.

Statement	Overall Mean	Mean - Females N=81	Mean - Males N=57	Significant difference P value.
Overall, the web site is attractive	5.64	5.70	5.53	
The web site has nice colors	5.64	5.80	5.42	
The web site has good graphics	5.50	5.74	5.16	p=0.33
The web site is easy to navigate	5.95	5.94	5.98	
The web site is enjoyable	5.42	5.59	5.18	
The web site makes sense	6.05	6.01	6.11	
The web site appeals to me	5.08	5.07	5.09	
I like the characters on the web site	4.89	5.07	4.62	
I would play the game again	5.16	5.35	4.96	

Table E: Perceptions of the web site

The above table reflects that the only statement where females and males difference was significant was in regards to the graphics of the website. All of the statements had a positive mean, suggesting both males and females enjoyed the various components of the web experience. Females, however, have a consistent overall mean higher on most of the items suggesting that females slightly prefer the site with the exception of the site making sense.

Conclusions

- Overall, there is good evidence of learning the desired messages.
- When looking at the data based on gender, female participants scored higher at a statistically significant difference, than male participants
- Both male and female participants demonstrated a statistically significant change in knowledge from pre-program to post-program
- Interestingly, males demonstrated a greater overall increase in their mean score on the knowledge questions
- Upon completion of the program, the difference between knowledge scores of male and female participants was no longer statistically significant.

- The site appeals to both males and girl, but females slightly prefer the site over males and are more likely to want to play again.

- The strongest element of the site is that it "makes sense" to the youth.

- The weakest elements of the site, though still positively viewed by the participants, are the characters.

- Although the site appears to be successful in revealing engineered design across daily life, the site does not appear to move students to seeing themselves in engineering related careers.

- On the other hand, there is only one area in which there is disagreement across a group of the participating students: only females do not see themselves as engineers.

- Although females demonstrate a higher knowledge of engineering concepts both pre and post-program, the idea of becoming an engineer is still not resonating with female participants.