



## Relationship Between Students' Demographics And Manufacturing Career Perceptions (Work in Progress)

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# **The Relationship between Children Demographics and Career Perceptions of Manufacturing (Work in Progress)**

## **Introduction**

While manufacturing continues to be considered the backbone of economic growth in the United States (Nadine & Gielczyk, 2018), manufacturers continue to express concerns related to the availability of a skilled workforce to fill the projected workforce demands—3.5 million available manufacturing jobs by the year 2025 (The Manufacturing Institute & Deloitte, 2015). The 2018 report by Deloitte and the Manufacturing Institute revealed that manufacturing executives believe there to be three main factors contributing to this concern: (1) the retirement of the baby boomer population, (2) the shifting skills sets related to the digitalization of manufacturing, and (3) the misperceptions that children and their parents hold of manufacturing jobs. Specific to concern number three, research has shown that society seems to hold a negative perception of manufacturing careers, which likely prevents many potential workers from entering the field (Bosman & Strimel, 2018; Deloitte, 2017; Krause & Strimel, 2019). There have been recommendations to establish industry-education partnerships starting as early as an elementary school in both formal and informal settings (Deloitte & the Manufacturing Institute, 2018). While there are numerous outreach initiatives related to career exposure and awareness, specifically in the arena of Science, Technology, Engineering, and Mathematics (STEM) education, there is a lack of research focused on how such initiatives can influence a child's perception of manufacturing and how this is related to their upbringing, community, culture, and general demographics. This study sought to determine the relationship between students' career perceptions of the manufacturing industry and their demographic characteristics. A *Manufacturing Career Perception Survey* was administered to K-12 students before and after a weeklong manufacturing outreach program titled *Manufacturing Week*. The significance of how each participant's response changed from pre-survey to post-survey was determined by individual demographics using one-way Analysis of Variance (ANOVA). Additional descriptive analyses were also carried out to better understand the ways that the participants responded to each survey question. For this study, the demographics considered were gender and ethnicity. The genders in this study were defined as Male/Female while the ethnicities were Caucasian/Minority. Participants from Minority backgrounds were all classified under one group category for data analysis purposes. This analysis can provide additional insight into how demographic backgrounds can be linked to how students perceive manufacturing careers. Recommendations will be suggested for future studies and outreach programs for equitable educational practices related to manufacturing career awareness and exposure.

## **Research Questions**

- RQ 1: What is the relationship, if any, between children's perceptions of manufacturing careers and their gender/ethnicity?
- RQ 2: What is the relationship, if any, between the influences of the *Manufacturing Week* activities on children's career perceptions and their gender/ethnicity?

## Methodology

This study focused on examining children's perceptions of manufacturing based on gender/ethnicity and whether there is any relationship between these demographics and the influence of industry-driven outreach on their career perceptions. The study investigated survey results collected from participants attending a K-12 career outreach event, titled *Manufacturing Week*. The goals of this event were to (1) bring awareness to the community about manufacturing in the region, (2) share with the future workforce the vast opportunities and career pathways available to them, and (3) provide opportunities for local youth to discover how they can learn, work, and live within the region. The *Manufacturing Week* participants were grouped based on their grade level, as the activities were age dependent. This included a *Manufacturing Workshop* for grades K-5 (ages 5-11), a *Manufacturing Expo* for grades 6-8 (ages 11-14), and *Manufacturing Tours* for grades 9-12 (ages 14-18). The *Manufacturing Week* leaders administered voluntary surveys to all students before and after each of the event activities.

The Manufacturing Workshop's goal was to create more awareness around manufacturing careers and included multiple stations, operated by associates from the participating manufacturers, that provided hands-on activities to showcase how production occurs, the concept of lean manufacturing, and how the local supply chain works. The pre- and post-survey questions were answered by 92 participants in the K-5 grade level. The Manufacturing Expo focused on career exposure whereas participating manufacturers provided a booth in which students could explore what their company does and perform activities related to the careers within their organization that design, produce, move, and support their products. The pre- and post-survey questions were answered by 238 participants in the 6-8 grade level. The 9-12 graders participated in Manufacturing Tours that were held at various manufacturing facilities within the local community. A total of 167 students in the 9-12 grade group completed the pre- and post-survey. For students in grades K-5, 43% of the participants were Male, 57% were Female, and 12% were Minority participants, while 88% were of Caucasian background. The 6-8 grade group had 53% Males and about 47% Females, 36% Minority, and 64% Caucasian participants. For participants in grade groups 9-12, 71% were Male, 29% Female, and 16% of the participants came from Minority backgrounds, while 84% were Caucasian.

Deidentified data were provided by the leaders of *Manufacturing Week* from these surveys following the exempt guidelines from the Institutional Review Board. The surveys were based on the Deloitte survey measuring parents' perceptions of manufacturing careers (Deloitte, 2017; Deloitte & Touche LLP, 2017). The survey (see Table 1) provided participants with a statement related to manufacturing careers and asked them how strongly they agreed or disagreed with that statement on a Likert scale (i.e. 'Strongly Disagree', 'Disagree', 'Neutral', 'Agree', 'Strongly Agree') (Krause & Strimel, 2019). The surveys varied by grade band based on reading level and question complexity

There were two sets of data analyses carried out for each grade level. The first analysis was carried out using data from the pre-survey to determine any relationship in the initial response based on gender and ethnicity. The second analysis was carried out using data derived from both the pre- and post-survey to obtain an understanding of the relationship, if any, between the influence of Manufacturing Week on career perceptions and gender/ethnicity. For numerical analysis to be performed, the responses were coded on a 5-point scale (i.e. 'Strongly Disagree' = 1 and 'Strongly Agree' = 5). Each column on the spreadsheet represented the survey questions. Three additional columns were included to calculate the total values of responses for each

**Table 1**  
**Pre- and Post-Manufacturing Career Perception Survey Questions/Statements**

Question	Response Type
Q1. What is your Gender?	Likert-scale
Q2. What is your Ethnicity?	Likert-scale
Q3. Do you know any adults that work in manufacturing? Examples of manufacturing workplaces are Subaru, Caterpillar, Wabash National, etc. (Yes or No Questions)	Likert-scale
Q4. I think there are many job opportunities in manufacturing.	Likert-scale
Q5. I think manufacturers need to be well educated.	Likert-scale
Q6. I think manufacturing jobs are safe.	Likert-scale
Q7. I think manufacturing jobs are clean.	Likert-scale
Q8. I think a manufacturing career would let me be creative.	Likert-scale
Q9. Have you been on a manufacturing tour or participated in manufacturing activities before?	Likert-scale
Q10. I have been encouraged to consider a job/career in manufacturing.	Likert-scale
Q11. I would consider a career in manufacturing.	Likert-scale
Q12. Manufacturing jobs pay well.	Likert-scale
Q13. There are many job opportunities in manufacturing.	Likert-scale
Q14. Manufacturers need to have a college degree.	Likert-scale
Q15. I think manufacturing careers use new technology.	Likert-scale
Q16. I think a manufacturer needs to be highly skilled.	Likert-scale
Q17. I think manufacturing is important to the United States economy.	Likert-scale
Q18. I think there is a need for more manufacturers in the United States.	Likert-scale
Q19. What surprised you about manufacturing?	Open-Response
Q20. What did you like about this experience?	Open-Response
Q21. What would you change about the experience?	Open-Response
Q22. How would you explain manufacturing jobs to a friend who has not done a tour of a manufacturing plant or another manufacturing-related activity?	Open-Response
Q23. Have you been on a manufacturing tour or participated in manufacturing activities before?	Open-Response

*Note.* Participants in grade group K-5 had Questions 1-5 on their survey, participants in grade group 6-8 had questions 1-15 as their survey questions, while participants in grades 9-12 were given all the survey questions.

student. The first and second additional columns contained the sum of each students' coded response score for each question on the pre-survey and post-survey respectively. The third column included in the spreadsheet was the "delta value" ( $\Delta$ ) that were calculated by subtracting their pre- and post-survey values. This value was used to gauge the perception changes between the pre- and post-survey responses. As such, the magnitude and direction of the participants' perception change are indicated with the  $\Delta$  value. The next process after sorting the data and calculating the  $\Delta$ s was to obtain the statistical significance of each survey by conducting a one-way ANOVA test on the IBM SPSS statistics package (version 26.0). A 95% confidence interval was used to determine the statistical significance of survey response as it related to demographics. In order to gain in-depth comprehension about this project, further analysis was carried out on excel. This was done to enable an in-depth understanding of the impact of each individual question on the children and to see the trend and patterns of the change in their responses. The mean values were categorized and sorted depending on the child's gender and then later depending on their ethnicity. The mean values were then compared to each other to get a more accurate depiction and conclusion of the result.

## Findings

### Research Question 1

The gender and ethnicity respectively served as the independent factor while the sum of each student's coded response score for each question on the pre-survey served as the dependent variable. The results show that there was no significant relationship between ethnicity and their responses to the pre-survey for participants in grades K-12. There was also no significant relationship between gender and responses for participants in grades K-8. However, there was a

significant relationship between gender and the total pre-survey responses for 9-12 graders ( $F(1, 165) = 14.679, p = 0.000$ ). Based on these data, it seems as though male participants held a more “favorable” perception of careers related to manufacturing. A descriptive analysis of the means of the individual questions was carried out which led to some interesting discovery in differences between groups. These discoveries are further explained in detail in the discussion portion of this paper.

## Research Question 2

In order to determine whether or not the influence of the *Manufacturing Week* activities on children’s perception of manufacturing was related to their gender and/or ethnicity, a one-way ANOVA was also conducted using the data from the pre- and post-survey responses. Here the gender and ethnicity served as the independent variables while the total delta values from the survey responses were used as the dependent variable. The results show no significant relationship between ethnicity and their change in perception for participants in grades K-12. There was also no significant relationship gender and their change in perception for participants in grades K-12. Similar to the results of research question 1, some interesting differences were also discovered between groups for the individual.

## Discussions

In the first research question, the analysis of variance results for participants in grades 9-12 depicted that males seemed to have a more “favorable” perception of manufacturing careers question responses to “Have you been on a manufacturing tour or participated in manufacturing activities before,” show that of the total 91 students that had prior experience in manufacturing, about 80% of them were males while only 20% were females. Additionally, half of the female students had no experience in manufacturing before the *Manufacturing Week* activities. This dichotomy in prior experience based on gender may indicated why male students had more favorable perceptions to manufacturing careers, as it indicates higher level of previous exposure.

Additionally, the total outcome of the variance test for the second research question based on gender were very close to significance in some cases. Results of the total delta data for children in grades K-5 yielded a calculated probability value (p-value) of 0.050 with males having a mean value of 2.78 and females having a mean value of 0.59. The total delta data results for children in grade 9-12 a p-value of 0.058, with males having a mean value of 2.59 and females having a mean of 4.28. The results from children illustrate that to a limited extent, the influence of *Manufacturing Week* activities on children’s perception of manufacturing was related to their gender. For children in grades K-5, males had a higher mean value than females; this indicates that the outreach program geared towards children in grades K-5 was more tailored to male students. The results for children in grades 9-12, females have a higher mean value compared to males. These results indicate that further work must take place for all students to have equitable experiences at outreach programs. The results produced about children’s perception in relation to their ethnicity results were all insignificant for children in all grades.

To determine the relationship between demographics (gender/ethnicity) and the survey responses for each individual question, the mean values for each participant group were calculated. At the end of the *Manufacturing Week* activities, there was a major difference in response for children in grades K-5 based on gender. The question “I think Manufacturing jobs are safe” indicated that females (-0.098) had a lower mean value compared to males (0.235). Females (0.463) had a higher mean value than males (0.373) for the question “I think



manufacturing jobs are clean”. Results from children in grades 6-8 also depicted that majority of the females had not been encouraged to consider a job/career in manufacturing, as the female (-0.027) mean value response was lower than the male (0.031) response. The results also showed that female children in grades 6-8 did not see manufacturing as creative, as males had a mean value of 0.023 for their responses while females had a mean value of -0.027.

Therefore, it is essential to engage more females in events like *Manufacturing Week*, as this can help to eliminate potential barriers that inhibit females from gaining experience in manufacturing and consequently lead them to pursue a career in manufacturing. *Manufacturing Week* activities will give females the opportunity to be exposed to the field of manufacturing and make it potentially more possible for them to picture themselves manufacturing-related roles in their future, thereby contributing positively to the gender gap in the manufacturing industry.

Data analysis of the questions with ethnicity as a factor indicated “I think manufacturers need to be well educated” stood out, Minority (-0.396) children in grades 6-8 had a much less mean value compared to Caucasian (0.212) children in that same grade level. This perception by the Minority students could have stemmed from the fact that most of them had never been exposed or participated in manufacturing activities and thus were also not encouraged to pursue jobs/careers related to manufacturing when compared to their Caucasian counterparts. Minority children in grades 9-12 also did not think that a career in manufacturing would enable them to be creative. The outcome may suggest that depending on children’s backgrounds, they may hold different perceptions of the potential opportunities that manufacturing jobs hold. This suggests that more work needs to be done in fostering an equitable approach to industry outreach, where barriers or misperceptions of careers are addressed. If all students are equipped with more industry exposure opportunities and adequate information about the manufacturing, then they will be able to make more informed decisions about their career pathways.

### **Conclusion**

The main purpose of this study was to examine participants’ perceptions of manufacturing based on gender and ethnicity and whether there is any relationship between these demographics and the influence of industry-driven outreach on their career perceptions. Based on the one-way ANOVA analysis, we found no significant relationship between demographics and the perception of manufacturing careers before and after the event except for males who seemed to hold a more favorable view of manufacturing before the event. However, based on the descriptive statistics for each individual question, some interesting differences between the participants' groups were found at the end of the *Manufacturing Week* activities. Through the delta analysis for the individual questions, it was discovered that fewer females in grades K-5 saw manufacturing as safe, delta analysis results from children in grades 6-8 indicated that fewer females were encouraged to consider a career/job in manufacturing. The delta analysis for the individual questions for children in grades 6-8 also revealed that Minority children had a less rounded perception of the manufacturing industry. These are just a few of the discoveries in differences, the rest is explained in detail in the discussion portion on this paper. In conclusion, as with any study, more research is necessary to better understand the influence of industry-driven outreach on children's career perceptions.

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