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Discussion

An Experiential Online Training Approach for Underrepresented Engineering and Technology Students

Arefeh Mohammadi [1,*], Kevin Grosskopf [2] and John Killingsworth [3]

[1] Engineering Education Department, Virginia Tech, Blacksburg, VA 24060, USA
[2] Durham School of Architectural Engineering & Construction, University of Nebraska, Lincoln, NE 68588-0500, USA; kevin.grosskopf@unl.edu
[3] College of Health and Human Sciences, Colorado State University, Fort Collins, CO 80523-1501, USA; j.killingsworth@colostate.edu
* Correspondence: arefehm@vt.edu

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Abstract: Workforce pipelines are essential to sustain a productive workforce in an increasingly competitive, high-tech environment. Advanced automation, sensors, materials and data analytics will increase the need for highly skilled workers in the manufacturing (and manufactured construction) sector. Attracting and developing the next-generation workforce is not without its challenges; however, students are often deficient in technical skills and generally have negative perceptions about manufacturing and construction. As a result, new education and training models have been developed to provide instruction at all levels of the educational system, with a focus on both traditional students and non-traditional students, including ethnic minorities, women, veterans, disabled persons and older adult learners. This study focused specifically on certain underrepresented students in STEM programs offered at community colleges in the Great Plains region of the U.S. An available online training program by the Society of Manufacturing Engineers was used as a contextualized online training tool. The Learning Management System embedded in this online training tool was used to gather student data. Conducting multiple regression analyses on the test outcomes, completion rates, and improvement between post-test and pre-test scores showed that female participants achieved greater improvement between pre- and post-test scores than males, and achieved higher rates of credentialing compared to all other demographic groups. African American participants achieved greatest improvement between pre- and post-test scores than all other ethnic groups while Hispanics achieved higher rates of module completion. Additionally, this study also examines the background related to contextualized teaching and learning, as well as the effectiveness of this delivery method for these underrepresented populations.

Keywords: experiential learning; STEM education; workforce development; online training

1. Introduction

Engineering and technology-related industries lack semi-skilled and skilled workers, especially in the manufacturing and construction sectors [1–3]. They also lack the capacity to provide training to entry-level and semi-skilled workers, especially for non-traditional and underrepresented workers. The entry-level workforce is increasingly comprised of older adults, women and minorities who often lack basic skills and who are unable to acquire these skills through traditional delivery systems [4,5]. In fact, 45.1% of the post-recession workforce is now comprised of women and minorities [6,7].

New approaches are needed to provide effective training for the adult learner, as well as flexible support for non-traditional students who must balance work–life demands with limited educational opportunities [8,9]. The National Center for Education Statistics defines non-traditional students as those who "*delay enrollment into postsecondary education, attend college part-time, work full time, are financially independent for financial aid purposes, have dependents other than a spouse, are a single parent, or, do not have a high school diploma*." [10].

To address these needs, a U.S. Department of Labor (DOL) grant was awarded to an educational consortium [11] in 2012 to increase and expand access to industry-recognized credentials for recession-displaced and underemployed workers in manufacturing industries. The goal of this project was to expand and improve the ability of this institutional consortium to deliver technology-enabled education and career training programs to displaced workers and underrepresented groups, such as women, minorities, veterans, and workers who face unemployment and underemployment. The data for this study was retrieved between 2012–2017, when the program was implemented in community colleges in the Great Plains region of the United States.

To provide instruction to both traditional and non-traditional students, including ethnic minorities, women, and adult learners, a transformational learning approach, Contextualized Teaching and Learning (CTL), was chosen using the Tooling U™ curriculum and learning management system (LMS). This training intervention consisted of modules with basic skills remediation blended with interactive labs and virtual reality exercises. Articulation agreements were developed to credit certificate courses to more advanced levels of training and education including 30 credit-hour (one-year) diplomas, 60 credit-hour (two-year) degrees, and four-year degree programs. Learning outcomes, defined by test scores, completed credit hours, course completions and earned credentials (e.g., certificates, diplomas and AAS degrees), were compared between demographic subsets within the study group. Participants were adults, aged 18 years and older, who had participated in grant-funded training programs and/or support services at one or more of the member institutions. This research aims to better prepare adult learners and other underrepresented students and workers for high-wage, high-skill employment or re-employment in STEM industries. In addition, it introduces innovative and effective methods for curriculum development and delivery that address specific industry needs and leads to improved learning outcomes and retention rates for participants. The comparison of student outcomes among demographic subsets of program participants provided useful information as to whether this transformational approach was an effective education and training strategy for women, minorities, older adults, and other underrepresented groups. The hypothesis for the research was:

Hypothesis 1. *Contextualized instruction does not improve student learning outcomes among underrepresented students (e.g., women, ethnic minorities, older adults, etc.).*

2. Literature Review

The community colleges of this part of the U.S.A. [12] serve a highly diverse population, which is comprised of both traditional and non-traditional students. Non-traditional students include large numbers of underrepresented people, such as women, minorities, and veterans who are STEM majors in community colleges. In this research project, students had the option to take online contextualized training for many STEM-related diplomas, degrees, and certificates. Consequently, it was important to locate and understand previous research that studied the adult non-traditional students in a Contextualized Teaching and Learning (CTL) environment. In 1999, the U.S. Department of Labor formed the Secretary's Commission on Achieving Necessary Skills (SCANs) to identify the skills young people need to succeed in the future workforce. Three of the key principles SCAN developed were joining knowledge and skills, learning abstract concepts through engaging in practical activities and connecting schoolwork with the real world [13]. The phrase contextualized teaching and learning has been consistently used in this research to refer to the training system that we offered to the experimental group in community colleges. However, throughout the literature, other terminology was used for contextualization [14–16].

Demographic background and underrepresentation: this research was critical in terms of students with various demographic backgrounds in the colleges that were studied. Prior research showed low patterns of persistence for Hispanics and African Americans, as well as low transfer and completion rates for these students. Clearly, much needs to be done to improve the retention and success of underrepresented students, especially in STEM areas. Prior research has shown African American and Hispanic students had lower rates of completion; only 14% of African American students and 20% of Latino students completed a degree or certificate within six years, compared to 29% of white students and 24% of Asian students. These low success and completion rates among underrepresented students at community colleges are even more crucial since almost three-fourths of all Latino and two-thirds of all African American students who go on to higher education begin their postsecondary education in a community college [17,18]. A few studies mention the effectiveness of contextualization for non-white students rather than white students. However, CTL was potentially valuable for both groups [19]. Research gaps suggested conducting more studies to gather information about the potential efficacy of contextualization specifically with low-skilled adult learners, whether in community college degree and certificate programs, or in adult basic education programs. Contextualization has the potential to promote the short-term academic achievement and longer-term college advancement of low-skilled students [19].

CTL and adult teaching and learning: another study published by the California State University Chancellor's Office showed that participation in high-impact practices improves both learning and persistence for all students, but particularly for those who have been historically underserved. This study also indicated that participation in more than one high-impact practice increased the benefits for these students [13]. As enrollments of underrepresented students intending to transfer to a four-year engineering program increase, additional programs need to be developed to ensure the success of these students and to facilitate the successful transfer and completion of their academic degrees [18]. Most of the literature indicated that contextualized teaching would benefit adult learners very well. Instructors can help adults acquire skills more rapidly than approaches that focus only on subjects. The students served by community colleges range in age from 17 to 61, with an average age of 26. Each of these students is an adult learner. CTL is most effective for adult learners because their experiences become stimuli for further learning [20]. Moreover, after a comprehensive review of the literature on CTL, Perin (2011) identified preliminary support for the hypothesis that low-skilled students can learn more effectively and advance to college-level programs more readily through the contextualization of basic skills instruction. Perin (2011) cited a shortage of rigorous studies of academically underprepared students in college or adult basic education programs, and adult learners in general. Too often, remedial math skills are taught independently of, or as a prerequisite to, occupational training, resulting in adult learner discouragement and high training program attrition rates. The CTLs that were offered through this project blend both basic skills and occupational training together in environments that allow students to visualize relationships between abstract ideas and practical applications. CTL has proven particularly effective for adult learners who value short, hands-on instructional segments where they can relate new skills to real-world experiences [11,21]. Perin (2011) suggested that low-skilled students can learn more effectively and advance to college-level programs more readily through contextualization of basic skills instruction. Another observation of the same study was that other programs that used CTL for underrepresented groups (e.g., COMETS) used contextualized teaching and learning to improve the retention and success of underrepresented students in foundational math, science and engineering courses. Perin (2011) cited a shortage of rigorous studies demonstrating the effectiveness of CTL for adult learners in adult vocational education programs.

According to the Research and Planning Group for California Community Colleges, CTL practices need the development of new instructional materials due to the limitations of traditional texts and their lack of relevance to students [13,22]. The study states that, in many cases, CTL practices need the development of new instructional materials. Significant time and resources were required to develop, document, and produce these materials at the beginning of the new CTL-friendly environment [23].

This research is unique because (1) there is no evidence of research into the contextualization of STEM program content in community colleges in the midwestern United States; (2) there is no extant research that examines the outcomes of an online CTL program based on the demographics of the students and outcome measures; finally, (3) this research investigates the correlation between student outcomes in a CTL program and the demographic background of the students.

3. Methods

In 2012, a U.S. Department of Labor (DOL) grant was awarded to an educational consortium to increase and expand access to industry-recognized credentials for recession-displaced and underemployed workers in manufacturing industries. In the U.S. state studied in [24], manufacturing industries produce small electronics, processed food, automobile parts, agricultural machinery, and renewable energy. Displaced and underemployed workers in these manufacturing industries consist of low-to-mid-skilled labor with disproportionately high numbers of older adults, women and ethnic minorities. This population often lacks both the basic skills to retrain, re-enter and advance in the workforce, and the means to overcome the socioeconomic barriers that prevent participation in traditional training programs. An educational consortium of five community colleges and University of Nebraska developed an entry-level training program as part of a new Diversified Manufacturing Technology (DMT) certificate. The DMT certificate provided 12 credit hours of training in basic safety, quality control, production and maintenance. The DMT certificate was aligned with the nationally recognized Manufacturing Skill Standards Council (MSSC), Certified Production Technician (CPT) program and was articulated towards other certificates, one-year diplomas and two-year associate degrees within the consortium. Since displaced and underemployed workers in manufacturing often lack the basic skills and means to complete traditional training programs, a contextualized teaching and learning (CTL) approach was implemented.

The focus of this research, consequently, was to determine whether CTL improved learning outcomes, particularly among older adults, women and ethnic minorities. A non-random population of 342 participants was chosen for the study, including 75 that were exposed to the online CTL intervention. Test scores, course completions, earned credentials and other learning outcomes were compared between demographic subsets within the experimental group. The study design was considered quasi-experimental since study participants and training interventions were not randomly selected. Tooling U™ modules were designed to provide foundational skills in 22 manufacturing-related areas at three competency levels (100—introductory, 200—intermediate and 300—advanced) in a sharable content object reference model (SCORM) format. For the MSSC-aligned DMT certificate, 82 contextualized Tooling U™ modules were selected in the primary areas of safety, quality control, production and maintenance; 53 with basic skills remediation, 28 with interactive labs and 14 with virtual reality (VR) exercises.

In consort with the curriculum, Tooling U™ provides a learning management system (LMS) to track individual student performance and determines the effectiveness of contextualized instruction to improve learning outcomes. Among the most important LMS metrics used are pre- and post-test scores for each course module. In addition, the LMS tracks course completions, time spent on each course module and many other performance factors that can be assigned to individuals or cohorts of individuals in a specific class or demographic group. From this information, differences in competency levels for incoming students can be normalized, and skills attainment through the Tooling U™ training intervention can be more accurately measured. Learning outcomes, such as Tooling U™ module completions and pre- and post-test scores, were also compared among demographic subsets of the study group to determine the effectiveness of contextualized training among older adults, women and ethnic minorities.

For data collection purposes, participant data was entered into a student intake and tracking database upon enrollment. Participant intake data included student age, gender, ethnicity, student status (full- or part-time), employment status (full-time, part-time or none), veteran status, disability and financial need (Pell Grant eligible). Participant tracking data included DMT courses completed and total credit hours completed, as well as certifications, diplomas and degrees awarded. For the experimental group, participant tracking data also included total Tooling U™ modules assigned and completed, module level (100, 200 and 300) assigned and completed and overall pre- and post-test scores.

Participants were assigned a confidential project code to protect their identity. Colleges maintained control of all personally identifiable information (PII). On a quarterly basis, the colleges' staff updated student records, both internal and from the Tooling U™ online LMS. The staff then provided coded (PII removed) participant intake and tracking data quarterly. With participant intake and tracking data, a matrix was first developed to quantify the differences in learning outcomes, such as Tooling U™ CTL modules completed and pre- and post-test scores among subsets of the experimental group. Second, a logistic regression model was developed to determine whether changes in contextualized teaching and learning (CTL) performance were associated with participant demographics, such as age, gender, ethnicity, enrollment status, employment status, veteran status, disability and financial need. For regression and logistic regression, if the probability value 'p' is > 0.05 (>1 in 20 are the odds that a change or difference can be explained by chance), then the relationship between the dependent and independent variable was considered not statistically significant. If $p \leq 0.05$, however, then the relationship between the dependent and independent variable was considered statistically significant.

Logistic regression was considered an appropriate regression analysis to use when the dependent variable was dichotomous (binary), since the demographic variables were all either binary or dichotomous in nature. Logistic regression was used to describe data and to explain the relationship between one dependent binary variable and one or more nominal, ordinal, interval or ratio-level independent variable [25]. After careful consideration of student data and primary missing data analysis, 58 students' data was used to run the multiple regression analysis. Additionally, stepwise selection was used, allowing for all possible demographic variables to be included or excluded from the logistic regression model. Kendall's tau b correlation coefficients were used for all pairs of regression variables (demographic variables). For regression analysis, the Statistical Analysis System (SAS) software was used for data analyses.

To further determine if demographic backgrounds of the CTL participants had an effect on learning outcomes, logistic regression was used. Binary logistic regression requires the dependent variable to be binary and ordinal logistic regression requires the dependent variable to be ordinal. Secondly, since logistic regression assumes that P (Y = 1) is the probability of the event occurring, it is necessary that the dependent variable is coded accordingly. That is, for a binary regression, factor level one of the dependent variable should represent the desired outcome. Thirdly, the model should be fitted correctly. Neither over-fitting nor under-fitting should occur. Fourthly, the error terms need to be independent. Logistic regression requires each observation to be independent. Logistic regression does not require a linear relationship, normality of the variables or residuals, or uniform variance. Logistic regression can also handle both continuous and categorical variables [26].

CTL participants who did not complete any credit hours or those who did not have a student ID were removed. As a result, there were a total of 58 observations (from the original 75) used to build the regression model. It was assumed that, if there was a missing value for a learning outcome variable, the student did not achieve that outcome. For all of the regression models shown, testing for the null hypothesis (e.g., changes in CTL performance were not associated with participant demographics) included setting the regression coefficient for that demographic variable to zero. In interpreting the results of regression tables, if the p-value is greater than ? = 0.05, then we fail to reject this hypothesis and conclude that the regression coefficient for that demographic variable is equal to zero. That is, we conclude that the demographic variable is not significant in the model and does not help to explain the variation in the learning outcome response (e.g., pre-test scores, post-test scores, course completions, etc.). If the p-value is less than ? = 0.05, then we reject the null hypothesis and conclude that the regression coefficient for that demographic variable is not equal to zero and that the demographic variable helps to explain the variation in the learning outcome response. That is, changes in the predictor's value (demographic variable) are related to changes in the response variable.

4. Results

A prior study has been done that shows the descriptive results. Based on our initial results, overall, female participants achieved greater improvement between pre- and post-test scores than males and were more likely to complete courses. African American participants achieved greater improvement between pre- and post-test scores, although Hispanics achieved higher rates of module completion. Participants older than age 45 had higher test scores and achieved higher rates of module completion than all other age groups, while students younger than 25 were significantly less likely to complete courses. Furthermore, comparisons of CTL and non-CTL group demographics and learning outcomes show the percentage of female participants in the CTL group was nearly three times the number of female participants in the non-CTL group. Ethnic minorities accounted for 40.5% of CTL participants compared to 25.6% of non-CTL participants [24].

In addition to credit hours, course completions and earned credentials, CTL-specific learning outcomes, such as Tooling U™ module completions and pre- and post-test scores were compared among demographic subsets of the CTL (experimental) group to determine the effectiveness of contextualized training among women, ethnic minorities, veterans, older adults, disabled persons, and participants requiring financial assistance.

4.1. Descriptive Comparison of CTL Demographic Groups

In this section, descriptive comparisons of CTL subgroup demographics and CTL-specific learning outcomes are presented. CTL-specific learning outcomes consist of Tooling U™ module completions, and, pre- and post-test scores taken for each module. Approximately half (53.4%) of CTL participants had pre-test scores of 60%–80%, with 41.4% scoring below 60% and 5.2% scoring above 80%. Average pre-test scores among male participants (60.7%) were slightly higher than female pre-test scores (57.7%), although CTL post-test scores were almost the same on average for both groups (83.3%). As a result, female participants achieved an average of 25.7% improvement between pre- and post-test scores compared to a 22.7% improvement for males. Furthermore, female participants achieved significantly higher rates of module completion (99.0) on average than males (69.7).

Average pre-test scores among white participants (61.1%) were higher than Hispanic (59.6%), African American (56.3%) and all other ethnic minority (58.8%) pre-test scores. Average post-test scores among white participants (84.4%) were also higher than Hispanic (81.8%), African American (82.8%) and all other ethnic minorities (78.6%). African American participants, however, achieved the highest average improvement between pre- and post-test scores (26.5%) compared to all other ethnicities. Hispanic participants achieved significantly higher rates of module completion (84.9) on average than white (80.6), African American (72.0) and all other ethnic (34.8) participants. Participants enrolled full-time achieved higher pre-test scores (60.5%) on average when compared to part-time participants (58.5%). Part-time participants, however, achieved higher post-test scores (83.2%) compared to full-time participants (82.6%) as well as higher rates of module completion (91.5–58.4, respectively).

Employed participants scored lower on pre- and post-tests, but achieved significantly higher rates of module completion (98.6) when compared to unemployed participants (64.5). Participants employed part-time achieved higher pre-test scores (62.5%) on average when compared to full-time participants (56.3%). Part-time participants also achieved higher post-test scores (84.9%) compared to full-time participants (83.5%), as well as higher rates of module completion (80.5–78.3, respectively). Participants older than 45 scored higher on pre-tests (61.3%), post-tests (86.2%) and achieved higher rates of module completion (90.1) than all other age groups. Participants younger than age 25 scored lower on post-tests (79.6%) and achieved lower rates of module completion (55.5) than adults age 45 and over.

Among veterans, average pre-test scores (67.4%) and post-test scores (87.6) were higher on average than all other demographic groups. Differences in pre- and post-test scores among disabled participants were insignificant when compared to non-disabled participants, although disabled participants achieved higher rates of module completion (87.3) compared to non-disabled participants (74.1). Among participants receiving financial assistance (e.g., Pell Grants), no significant differences in pre- and post-test scores or module completions were observed with respect to the CTL population.

Within the CTL group, a total of 4326 Tooling U™ modules were completed. Of these, 1381 (31.9%) modules were completed by 48.3% of participants scoring less than 60% on module pre-tests (60.0% average). By comparison, nearly twice the number of Tooling U™ modules (2945) were completed by the other 68.1% of participants scoring 60% or above on module pre-tests (82.7% average), suggesting that prior training and experience was a factor in successfully completing course modules. Similarly, 1077 (24.9%) of modules were completed by 29.8% of participants scoring 60–80% on module post-tests (63.4% average). By comparison, roughly three times the number of Tooling U™ modules (3231) were completed by 64.9% of participants scoring above 80% on module post-tests (87.3% average). The findings suggest that significant improvements between total average pre-tests (60.0%) and total average post-tests (83.4%) occurred as a result of the contextualized training curriculum, including participants who did not appear to have prior training and experience.

Participants achieving a 20% or greater improvement between CTL pre- and post-test scores were also more than twice as likely to complete credit hours toward a DMT credential (e.g., certificate, diploma or degree) when compared to participants achieving a 10% or less improvement. Female participants in the CTL group achieved a 32.6% higher rate of credentialing when compared to male participants. In fact, females achieved a higher rate of credentialing when compared to all other demographic groups in both the CTL and non-CTL groups, despite more than two-thirds of female participants being enrolled only part-time. White participants in the CTL group achieved a higher rate of credentialing when compared to African American (15.9%) and Hispanic (19.7%) participants. Participants older than 45 achieved the highest rate of credentialing (67.9%) among all age groups, whereas participants younger than 25 achieved significantly lower rates of credentialing in both CTL and non-CTL groups.

4.2. Inferential Comparison of CTL Demographic Groups

In this section, inferential comparisons of CTL subgroup demographics and learning outcomes are presented. A logistic regression model was developed to determine whether changes in CTL performance were associated with participant demographics, such as gender, ethnicity, student status, employment status, veteran status, age, disability and financial need. Stepwise selection was used, allowing for all possible demographic variables to be included or excluded from the model.

4.3. Linear Regression

Table 1 shows the demographics that are not significant in the model and do not help to explain the variation in the pre-test scores.

Table 1. Pre-test scores regressed on demographic backgrounds.

Type I Tests of Fixed Effects				
Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**
Age (continuous)	1	45	0.11	0.74
Age Group	3	43	0.14	0.94
Gender	1	45	0.69	0.41
Ethnicity	4	41	0.42	0.79
Military Status	3	40	1.56	0.22
Disability	1	45	2.51	0.12
Pell Grant	1	20	1.00	0.33
Student Status	1	44	0.52	0.47
Employment	3	43	1.54	0.21

Changes in the continuous variable of age and the categorical variables of age, gender, ethnicity, military status, disability, Pell Grant, student enrollment status and employment are not associated with CTL pre-test scores.

Table 2 shows that the demographic variables listed are not significant in the model and do not help to explain the variation in the post-test scores.

Table 2. Post-test scores regressed on demographic backgrounds.

Type I Tests of Fixed Effects				
Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**
Age (continuous)	1	44	0.79	0.38
Age Group	3	42	0.96	0.42
Gender	1	44	0.02	0.90
Ethnicity	4	40	0.61	0.66
Military Status	3	39	2.21	0.10
Disability	1	44	0.70	0.41
Pell Grant	1	19	0.15	0.71
Student Status	1	43	0.03	0.87
Employment	3	42	0.59	0.62

The type 3 analysis of effects table shows the p-value for the overall effect. The categorical variable of gender is associated with completion of the "Manufacturing" course. Female students were more likely to complete the course.

The estimated logistic regression equation is:

$$\frac{\hat{p}}{(1-\hat{p})} = 0.4817 + 0.9046 \times gender$$

where $\hat{p}$ is the estimated probability of completing the "Manufacturing" course.

Changes in the continuous variable of age and the categorical variables of age, gender, ethnicity, military status, disability, Pell Grant, student status and employment are not associated with CTL post-test scores.

4.4. Logistic Regression

Changes in the continuous variable age and categorical variables of age, gender, ethnicity, military status, disability, Pell Grant, student status and employment are not associated with whether or not a student completed the "Safety" course. Changes in the variables gender, ethnicity, military status, disability, Pell Grant, student status and employment are not associated with whether or not a student completed the "Maintenance" course. The categorical variable of age group (20–30 years old) is associated with whether or not a student completed the "Maintenance" course. Students younger than 25 were significantly less likely (about one-tenth as likely) to complete the course when compared to students older than 45.

Changes in the categorical variables ethnicity, military status, disability, Pell Grant, student status and employment are not associated with whether or not a student completed the "Manufacturing" course. However, the categorical variable of age group (20–30 years old) is again associated with whether or not a student completed the "Manufacturing" course. The regression coefficient in the first compiled table is significant, but the confidence interval for the odds ratio in the second table does include zero (indicating the odds of completing the course are not different for age groups one and four). The categorical variable of gender is associated with completion of the "Manufacturing" course. Female students were more likely to complete the course.

4.5. Correlation

As shown (Table 3), Kendall's tau correlation coefficients for all pairs of regression variables are provided. Kendall's tau correlation coefficients assess statistical associations based on the ranks of the data. Ranking data is carried out on the variables that are separately put in order and are numbered. Correlation coefficients take the values between minus one and plus one. The positive correlation signifies that the ranks of both the variables are increasing. On the other hand, the negative correlation signifies that, as the rank of one variable is increased, the rank of the other variable is decreased [27]. Age (continuous) and age group are highly correlated, as would be expected. Age group is also significantly correlated with veteran status and employment—both are negatively correlated, meaning that students in higher age groups tend to be in lower-valued groups of veteran status and employment. Continuous age is negatively correlated with employment, with the same interpretation. Veteran status is negatively correlated with Pell Grant eligibility, but is positively correlated with college enrollment status.

Table 3. Kendall's tau b correlation coefficients for the demographic variables.

Kendall's tau b Correlation Coefficients Prob > |tau| Under H0: Tau = 0 Number of Observations									
	Age	**Age (Groups)**	**Gender**	**Ethnicity**	**Veteran Status**	**Disability Status**	**Pell Grant**	**Enroll Status**	**Employ Status**
Age	1.00	0.86	−0.06	−0.04	−0.24	−0.15	0.13	−0.08	−0.23
		<0001	0.56	0.68	0.02	0.17	0.43	0.50	0.02
	58	58	58	57	55	58	28	56	58
Age (groups)	0.86	1.00	−0.15	−0.02	−0.23	−0.15	0.09	−0.08	−0.27
	<0001		0.21	0.89	0.05	0.21	0.63	0.53	0.01
	58	58	58	57	55	58	28	56	58
Gender	−0.06	−0.15	1.00	−0.09	−0.04	−0.01	0.20	−0.06	0.10
	0.56	0.21		0.44	0.78	0.97	0.29	0.68	0.41
	58	58	58	57	55	58	28	56	58
Ethnicity	−0.04	−0.02	−0.10	1.00	−0.03	0.11	−0.01	−0.05	−0.07
	0.68	0.89	0.44		0.80	0.37	0.96	0.69	0.58
	57	57	57	57	54	57	27	55	57
Veteran Status	−0.24	−0.23	−0.04	−0.03	1.00	−0.16	−0.30	0.35	0.01
	0.02	0.05	0.78	0.80		0.19	0.10	0.01	0.91
	55	55	55	54	55	55	27	53	55
Disability status	−0.15	−0.15	−0.01	0.11	−0.16	1.00	0.19	−0.14	0.00
	0.17	0.21	0.97	0.37	0.19		0.32	0.31	0.98
	58	58	58	57	55	58	28	56	58
Pell Grant eligibility	0.13	0.09	0.20	−0.01	−0.30	0.19	1.00	0.21	0.27
	0.43	0.63	0.29	0.96	0.10	0.32		0.29	0.12
	28	28	28	27	27	28	28	27	28
Enrollment Status	−0.08	−0.08	−0.06	−0.05	0.35	−0.14	0.21	1.00	0.02
	0.50	0.53	0.68	0.69	0.00	0.31	0.29		0.84
	56	56	56	55	53	56	27	56	56
Employment	−0.23	−0.27	0.10	−0.07	0.01	0.00	0.27	0.02	1.00
	0.02	0.01	0.41	0.58	0.91	0.98	0.13	0.84	
	58	58	58	57	55	58	28	56	58

5. Discussion

This is a study of students of community colleges in STEM programs, aimed at understanding the effects of contextualized teaching on those with various demographic backgrounds, including women, minorities, and underrepresented populations. In addition, we seek to understand the differences in test scores for students in an online contextualized program. This research is significant—as the U.S. Bureau of Labor Statistics employment projection for 2016–2026 is released, there is a need for manufacturing and construction work force [28]. The offered programs that have been studied use an online contextualized curriculum that provided best learning experiences for students to prepare them for the STEM workforce. This research studied the central phenomenon of online contextualization by investigating student data from a community college in the Midwest.

Female participants achieved greater improvement between pre- and post-test scores than males and were more likely to complete courses. African American participants achieved greater improvement between pre- and post-test scores than all other ethnic groups, while Hispanics achieved higher rates of module completion. Participants older than age 45 had higher test scores and achieved higher rates of module completion than all other age groups.

Female participants achieved higher rates of credentialing compared to all other demographic groups in both the CTL and non-CTL groups, despite more than two-thirds of female participants being enrolled only part-time. The research shows there are few numbers of female students in the manufacturing and construction programs [12,29]. However, knowing the results of female students in the online contextualized program is very promising, and augments what the literature suggested in terms of the underrepresentation of women in STEM and the enormous potential for them to enter into these fields, which is also consistent with what other studies revealed in the literature [30]. Disabled students encounter various challenges in educational settings, especially in STEM education. Data must be available that provides an insight into the situation of college disabled students as a great part of the workforce [31]. This study has dug into the results from disabled students in colleges and has gone some way towards filling this gap in the literature.

The current literature showed a lack of studies on the effectiveness of online CTL programs for underrepresented college students in STEM majors with various demographic backgrounds. This research was able to articulate the effectiveness of online contextualized training for community college students including underrepresented population in comparison to traditional methods of delivery. The hypothesis for the research was:

Hypothesis 2. *Contextualized instruction does not improve student learning outcomes among underrepresented students (e.g., women, ethnic minorities, older adults, etc.).*

The results indicate that contextualized training, used in conjunction with traditional instruction which is delivered online, improved learning outcomes for most participants, especially among older adults (>45), ethnic minorities and women. Consequently, the null hypothesis is rejected.

The adults are very challenged by the curriculum as explained by the instructors in the colleges under study. The content is great, and the online system allows adult learners to take the course at their own pace while they receive support from the instructors through classroom and online inquiry. Moreover, some adult learners need to take basic skills remediation as a part of the program to get ready for the modern industry workforce.

This study has limitations that should be considered in interpreting the results. First, all participants are in majors related to STEM, but they do not necessarily characterize a similar background. Sometimes a researcher needs a participant, or he/she only has access to a certain group of participants. This means that the researcher collects participants in a group that cannot or should not be divided up or, more simply, the researcher cannot randomly assign the participants. This non-equivalent group is defined as an experiment where existing groups are not divided [32,33]. The limitations of a quasi-experimental study do not allow researchers to randomly assign students to a group. In this research, we only had access to a certain group of participants. There was limitation in the sampling because access to five colleges was possible over a limited timeframe of four years. The result of this study is limited to Midwestern community colleges and two-year STEM programs. The size and homogeneity of the experimental group negate the generalizability of the results.

Other limitations of this research also include a relatively small study population, particularly within subsets of demographic groups. The descriptive analysis of the data poses some limitations in making assumptions about a population. Regression analysis requires a population size of at least 84 to achieve 80% power. Multiple unknown variables exist that may not have been considered as influencers in the test scores and variables related to achieved credentials. This study did not set out to determine causality, but merely causal relationships of influential variables within the various demographics of the students.

6. Conclusions and Future Research

Implementing CTL in new manufacturing or construction programs requires a prominent level of flexibility and open-mindedness from instructors and policy makers [34]. Strong college leaders will need to provide ongoing direction and support for online contextualized programs for students with varied demographic backgrounds. This research informs administrators and educators to use more contextualized content for the diverse student population of today's community colleges. The existing online contextualized programs that are available can be applied in colleges. The Society of Manufacturing Engineers provided great material online for students in manufacturing programs. However, similar efforts are needed to provide online training programs that are contextualized for construction students' training. The college leadership can extend online contextualized teaching methods to non-CTL faculty and programs and train them to teach in experiential teaching environments, especially when dealing with a higher number of adult learners in a program. This research provides a solid foundation for introducing contextualization into community college programs. Based on the results of this research, the policy makers and administrators of colleges can conduct a college-wide contextualization readiness survey.

This research informs ways to provide training programs for a diverse student population who will be the future STEM workforce. Diversity in the workplace can be promoted by allowing programs such as the one described in this study in community colleges. The efficiency of the offered program allows for a wide population of the workforce to receive certification and recertification to work in STEM industries and partially covers the huge gaps in the workforce in these areas.

To successfully deliver online content, teachers should be ready to encounter the challenges involved with an online class. An elevated level of awareness about students and their various needs is needed by the teacher. If teachers could use some hands-on exercises to familiarize the students with the machines and equipment, some difficulties could be solved.

If a college provides environments for teachers to incorporate the contextualization of manufacturing and construction equipment, it helps both teachers and students to learn more about the real world. Furthermore, teachers need support in terms of teaching basic skills, such as computer literacy, to students who need it. As a part of the grant, basic skills remediation was embedded in the curriculum. Teachers should be provided with opportunities to deal with diversity in the classroom; they should be trained to work with diverse students with various demographic backgrounds.

Because of the success of the program for veteran students, the research recommends the use of CTL for the veteran population who are in similar programs in community colleges. Unlike the results of some previous research about the inefficiency of online programs, the research provided strong results that CTL that is delivered online was efficient for most of the demographic groups of students.

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