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Board 229: Can You See Yourself Here? Broadening Participation in STEM through Virtual Reality Career Exploration

Dr. Sarah Lynn Ferguson, Rowan University

Dr. Ferguson is the STEM VRCE project team leader, investigating the magnitude impact of STEM career exploration through the use of virtual reality video. An applied methodologist in education research, Dr. Ferguson focuses on the application of advanced research methods and statistics approaches to issues in education. Currently Dr. Ferguson works as an Associate Professor of Quantitative Methods at Rowan University, teaching education research courses in the College of Education. Prior to this role, Dr. Ferguson was a certified teacher in the state of Texas with certifications in Elementary Education, Middle School Science, and High School Science.

Christopher J Winkler, Rowan University
Kara P. Ieva
Marjorie Blicharz, Rowan University
Theresa E. Cann
Ashley Elmes

Can you See Yourself Here? - Broadening Participation in STEM Through Virtual Reality Career Exploration

The challenges of increasing participation in STEM for underrepresented groups has been an ongoing area of research, and these challenges are augmented in rural school districts [1]. Rural school districts make up over 50% of the public school districts in the United States, serving approximately 20% of all students [1]. However, rural districts often lack access and funding for special projects and programs such as STEM career exploration and advanced courses [2], [3]. STEM technician and technologist careers in particular can be accessible options for students; however, many students are not aware of these career options and have limited access or resources to explore these careers through the current school-based career guidance programs, particularly in rural communities [4], [5].

I. Literature Review and Theoretical Framework

There have been numerous calls for more STEM specific career exploration and advising to meet the needs of the modern workforce [4], [6], [7]. Virtual reality with 360 videos (360/VR) have been found as a useful tool for career development as it meets students' preferences for realistic and engaging content [8], [9]. VR experiences provide students with an opportunity to drop into a new environment, to experience the setting around them, and engage with new material; this interaction and engagement increases interest and self-efficacy for the specific career [9], [10], [11]. Immersive virtual experiences can also bridge the gender gap in science fields [12], while also systematically reducing costs and travel time, and increasing safety and flexibility in a controlled environment for schools and employers providing these experiences to students [13], [14].

Social Cognitive Career Theory (SCCT) provides an understanding of how a person pursues a career based on their self-efficacy and expected positive benefits from the career in question [7], [8], [15]. Self-efficacy is crucial as an individual needs to believe in their abilities to complete career-related tasks, have access to the career, and receive guidance from external supports [7], [8], [15]. Especially for students in middle to high school, exposure to a career, understanding required skills, and knowing they have the ability to create positive outcomes is imperative in navigating career options [7]. Research has shown that experiential learning opportunities, such as VR simulations, increase students' self-efficacy and ability to see the career as a positive addition to their life [8]. SCCT also acknowledges that external factors like identities (racial, ethnic, gender, class) impact an individual's access to career choices, overall interests, and self-efficacy [15].

II. Present Study

STEM-VRCE is a NSF Broadening Participation EHR:Core project that offers a novel approach to address the need for more accessible [16], [17] career exploration using 360/VR videos. With SCCT as a framework, *STEM-VRCE* addresses the lack of opportunities to develop self-efficacy in STEM career fields for underrepresented groups, especially those in rural school districts, through the use of 360/VR videos and curriculum modules. *STEM-VRCE* therefore offers a novel approach with 360/VR videos that, if found to be effective, could be scaled up to support career exploration around multiple STEM career clusters (ie: survey and mapping

engineering technician) and potentially change the way we offer career exploration programming. The primary research question guiding the experimental study in this project is: What is the magnitude of the effect of a STEM career exploration intervention using VR/360 videos technology on student interest in STEM, career decision making self-efficacy, and knowledge of the targeted career, taking pre-test levels into account?

III. Methods

For the first implementation year, a research study was conducted with three partner high schools classified as rural. An experimental study design with randomization within clusters was used to estimate the effectiveness of the VR technology career exploration intervention. There were two groups in this experimental design: a control group that had "business as usual" meetings with their school counselor, and a treatment group that received the intervention using the developed career exploration intervention with the VR technology. Randomization was done within the school cluster, with each school having a random set of students that received the intervention, and a random set of students that were the control group. Students in the treatment group were provided with a virtual reality headset to view the videos during their scheduled 1-hour school counselor meeting. Following the data collection for this study, the students in the control group were given access to the VR intervention materials, to allow for ethical distribution of the potential knowledge and benefit of the intervention.

Each school recruited 11th grade students to participate, who were then randomly assigned to treatment (n = 59) or control conditions (n = 32). Students in the study were predominantly from School 1 (45%) and School 2 (39%), with School 3 having the smallest sample (16%). Students in this study were predominately White (64%), with 18% being Black or African American, 8% Asian, 1% American Indian or Alaskan Native, with one student selecting Native Hawaiin or Pacific Islander, and 8% choosing to self-identify. Self-identified responses included Hispanic or Latino (four students), Middle Eastern (one student), Salvadorian (one student), and Mixed (one student). Additionally, 17% of respondents noted they were of Hispanic or Latino origin or descent. Of the total sample, 52% identified as Male, 45% identified as Female, and 2% as Non-Binary, with 1 student preferring to not identify their gender for the study.

A. Data Collection

Data collection for the study took place at two points in time, pre and post intervention. Pre-intervention data collection included a student demographic survey recording student race/ethnicity, gender, etc. Measures of science interest (Science Motivation Questionnaire II; [18]), career decision self-efficacy (Career Decision-Making and Self-Efficacy Brief Decisional scale; [15]), and knowledge of engineering technician careers (researcher developed Career Knowledge measure) were used to measure the study outcomes of interest at both pre-intervention and post-intervention, allowing for comparison over time. For the Career Knowledge measure on the engineering technician careers, a measure of students' prior career knowledge specific to technical careers was developed. The measure asked respondents to indicate their agreement with statements about education requirements, types of jobs available, salary expectations, physical requirements, mental requirements, status expectations, and potential enjoyment related to surveying and mapping technician careers [19].

B. Analytic Approach

Data cleaning was conducted first, removing responses with more than 50% missing data and removing duplicates from the data file. Next, outcome variables for the study were checked for outliers and non-normality, supporting the assumptions for the planned analysis. An analysis of covariance (ANCOVA) [20] was used to answer the research question in this study with the first year implementation data, providing a mechanism for comparing the treatment and control group post-test data for each outcome, while controlling for the pre-test level. Concerns regarding independence of the three outcomes could not be addressed using a multivariate analysis given the small sample size for this initial study, so interpretations will focus on η^2 effect sizes over statistical significance, and the *p*-value alpha level has been adjusted to 0.017 as a Bonferroni correction (0.05 / 3 = 0.017).

IV. Results

Descriptive statistics were used to check normality of the continuous outcome variables, and all three were found to meet the assumption of a normal distribution (skewness and kurtosis within +/- 3.00). Pre-test and post-test descriptive statistics are reported in Table 1, including mean, standard deviation (SD), skewness, kurtosis, and their associated standard errors (SE). Next, three ANCOVA analyses were conducted, one for each outcome variable.

TABLE I.
Descriptive statistics for outcome variables for both treatment conditions

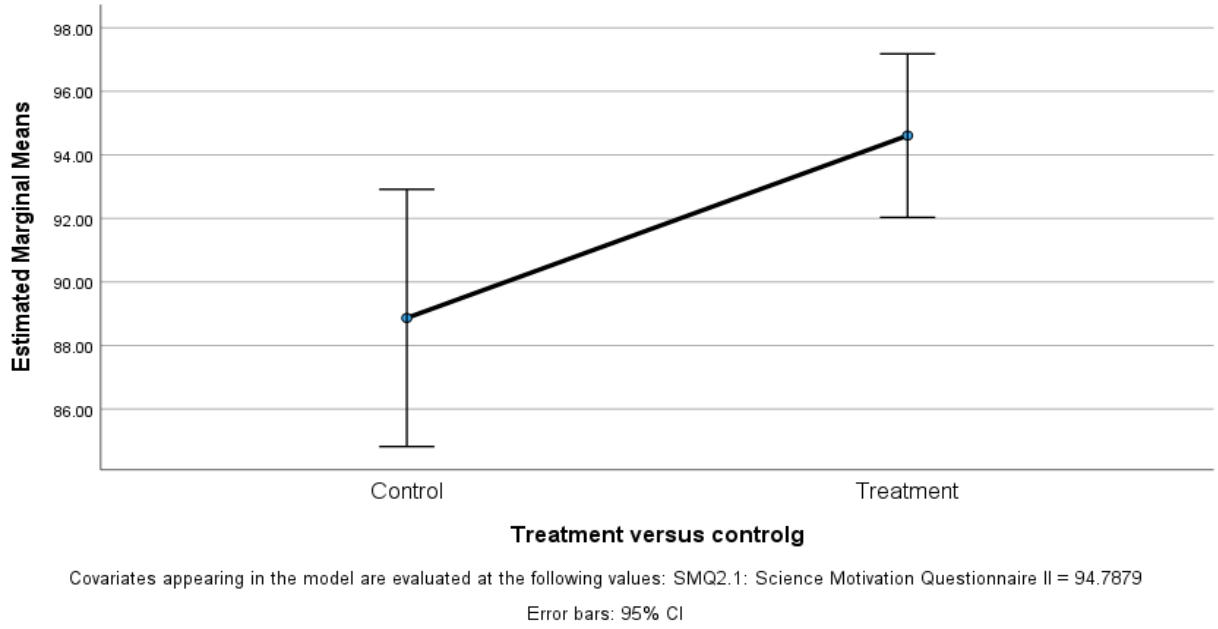
Outcome Variable	Pre-Test			Post-Test		
	Mean (SD)	**Skewness (SE)**	**Kurtosis (SE)**	**Mean (SD)**	**Skewness (SE)**	**Kurtosis (SE)**
Science Motivation	95.28 (17.00)	-0.29 (0.25)	-0.47 (0.49)	92.95 (18.08)	-0.41 (0.30)	-0.60 (0.58)
Career Decision Self-Efficacy	31.44 (5.22)	-0.50 (0.24)	0.84 (0.48)	31.17 (5.62)	-0.44 (0.30)	-0.12 (0.58)
Target Career Knowledge	16.84 (8.07)	0.40 (0.25)	-0.98 (0.50)	21.98 (6.97)	-0.52 (0.30)	-0.36 (0.60)

A. Science Motivation

For the variable science motivation, homogeneity of variance was checked using Levene's test and the assumption was met ($F_{(1, 64)} = 2.43$, $p = 0.12$), supporting the use of the analysis for comparison. The analysis was found to be statistically and practically significant, $F_{(2, 65)} = 104.76$, $p < 0.001$, $\eta^2 = 0.77$. The variance between the groups associated with the intervention is small but significant, with a partial $\eta^2 = 0.08$. Additionally, the analysis achieved adequate power, with β-1 = 1.00 for this data. This result indicates that there are meaningful

differences between the treatment and control group on science motivation, controlling for prior motivation at pre-test (see Figure 1).

Fig. 1. Group difference in science motivation for control vs. treatment



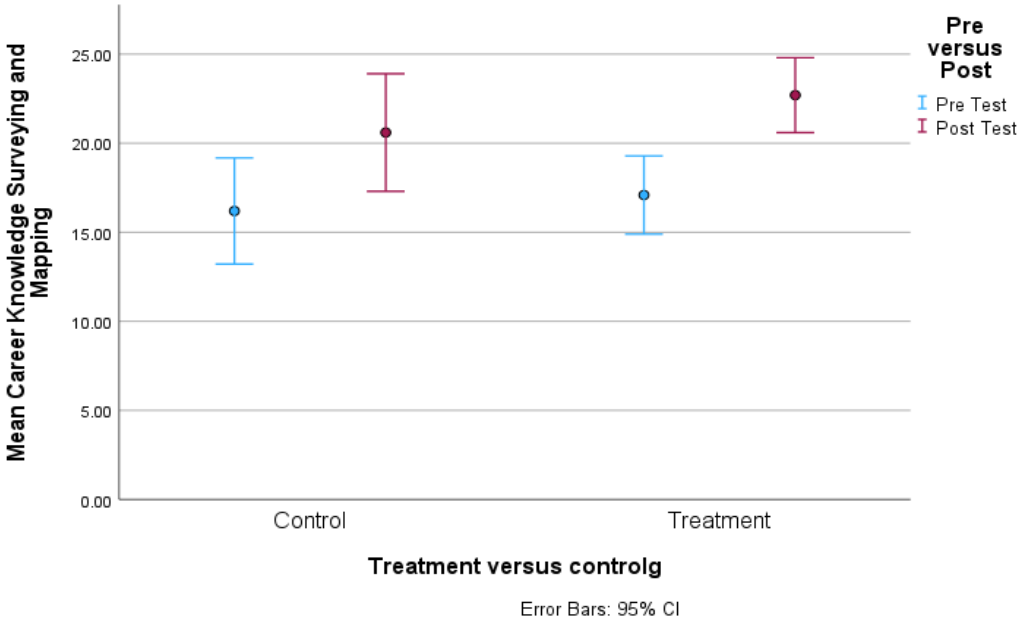
B. Career Decision Self-Efficacy

For the variable target career decision self-efficacy, homogeneity of variance was checked using Levene's test and the assumption was met ($F_{(1, 64)} = 0.10$, $p = 0.75$), supporting the use of the analysis for comparison. The analysis was found to be statistically and practically significant, $F_{(2, 65)} = 15.93$, $p < 0.001$, $\eta^2 = 0.34$. However, the variance between the groups associated with the intervention was not significant, with a partial $\eta^2 = 0.000$. The overall analysis did achieve adequate power, with $\beta\text{-}1 = 0.99$ for this data. This result indicates that there are meaningful differences over time for career decision-making self-efficacy, but these differences are not meaningfully different between the treatment and control groups, controlling for prior levels at pre-test.

C. Target Career Knowledge

For the variable target career knowledge focused on surveying and mapping technician careers, homogeneity of variance was checked using Levene's test and the assumption was met ($F_{(1, 59)} = 0.01$, $p = 0.91$), supporting the use of the analysis for comparison. The analysis was not found to be statistically significant (at the corrected alpha level) though the effect size indicates a small effect, $F_{(2, 60)} = 7.12$, $p = 0.02$, $\eta^2 = 0.20$. Additionally, the variance between the groups associated with the intervention was practically significant but not statistically significant, with a partial $\eta^2 = 0.17$. The analysis did achieve adequate power, with $\beta\text{-}1 = 1.92$ for this data. This result indicates that there are potentially meaningful differences between the treatment and control groups on target career knowledge, controlling for prior knowledge at pre-test, but this analysis should be repeated with new data to further explore the effects (see Figure 2).

Fig. 2. Group differences in career knowledge over time for control vs. treatment



V. Discussion

Initial results from the first implementation year data support the positive impact *STEM-VRCE* can have on high school students' motivation and career exploration in science and engineering careers. Positive effects for the treatment group in increasing science interest and knowledge of the target career (i.e., survey and mapping engineering technician) aligns with the SCCT conception that learning experiences increase self-efficacy and outcome expectations for career development [15]. The effects for the treatment group on career decision-making self-efficacy are less supported in this initial analysis, potentially due to the more distal nature of career decision making as an outcome for these students. The results in the present analysis also support the prior literature on 360/VR videos as a new medium for learning and development of self-efficacy for students [8], [9], [10].

Future research will continue to explore the meaningfulness of 360/VR videos from *STEM-VRCE* as a tool for career exploration of high need engineering technician/technologist careers. The second implementation year data is being collected currently and will be compared to this dataset in future research to further explore the effects. Pending results from this project, a scale up study will be conducted to compare the data from these three partner schools against data from a larger population of students across the country. Based on the results of these expanding projects, there is significant potential to scale up the *STEM-VRCE* implementation and expand the available modules to support career exploration and advising around multiple STEM career clusters, providing a new avenue for career exploration programming. Especially as a tool to increase access and potentially broaden participation in these career fields [12], [13], [14], *STEM-VRCE* represents one avenue of change for modern career development.

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