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EDTC 810 Statistics for Education Research

Assignment 1: Methods of Literature Review

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Research Study One

The study, “Effect of science virtual laboratory combination with demonstration methods on lower -secondary school students’ scientific literacy ability in a science course”, was conducted by authors Lestari et al., (2023) on 102 students in Indonesia and tested the effect of virtual laboratory in combination with demonstration methods on student’s scientific literacy ability. The design of this research is quasi-experimental as three groups - Experiment 1(used virtual laboratory media), Experiment 2 (used virtual laboratory media and demonstration method) and Control (used demonstration methods only) were tested with pretest and posttests for scientific literacy ability. The tests were developed specifically for this study.

The scientific literacy ability was analyzed using descriptive statistics (mean and standard deviation). Mixed design ANOVA analysis was used to determine the difference in the pretest-posttest of scientific literacy ability in the three groups. The study exhibited some degree of internal validity since it compared the pre- and post-test results of the two groups (experimental and control), which helped in establishing whether the intervention led to any observed changes in scientific literacy. The study’s finding are generalizable to a similar population but may be constrained by contextual factors such as sample size and geographic location.

Research Study Two

In the study “Assessing the impact of a virtual lab in an allied health program”, the authors Kay, Goulding and Li (2018), conducted a mixed method (convergent design) study on 64 allied health students in Canada in which they investigated the benefits, challenges, and perceived impact of a virtual lab in an allied health program.

The data was collected using a Likert scale survey, open -ended questions and think -aloud video clips of students while conducting the lab. Descriptive statistics (e.g., mean, standard

deviation) was used for survey responses, and the open-ended responses were analyzed thematically. The think aloud video clips were recorded using a screen casting software and underwent a coding and analysis process similar to the open-ended responses. Internal validity was ensured through pre/post-test comparisons and thematic analysis of interviews. The generalizability of the study was limited due to its focus on only allied heath students from a single institution in Canada and its small sample size; however, the results may inform similar educational contexts.

Research Study Three

The study "The impact of Virtual Lab Learning experiences on 9th Grade Students' Achievement and their attitudes towards Science Learning by Virtual Lab" was conducted by authors Ambusaidi et al., (2018) on 69 9th grade students in Oman. A quasi -experimental design was used in this study.

One achievement test and two scales (attitude towards science and attitude towards virtual labs) were developed by the authors. The achievement test had 8 multiple choice items and 13 open - ended questions. The attitude scales had Likert type questions. The tests were developed by the authors specifically for this study. The validity of the scale was examined by a panel of eight reviewers who were specialist in curriculum and instruction and seven science supervisors who worked at the Ministry of Education in Oman.

The data collected was analyzed by descriptive statistical methods like mean and standard deviation for achievement test and attitudes towards science were calculated before the treatment and a t-test (inferential statistics) was used to determine if there was a significant difference between the two means of each test. The internal validity is strong due to the use of pre/post-test

comparisons and a control group, but the generalizability is limited by the specific sample (9th grade students) geographic location (country of Oman), and the type of virtual lab used.

Research Study Four

The study "The Effect of the Virtual Laboratory on Students' Achievement and Attitude in Chemistry" was conducted on 341 9th grade students Turkey by the author Cengiz Tuysuz (2010). It utilizes a quasi -experimental design with an experimental – control group model and investigated the effect of virtual labs on students' achievement and attitude.

Two scales – Knowledge scale (KS) and Chemistry Attitude scale (CAS) were developed by the author specifically for this study and used to collect data and to measure the difference in the students' knowledge levels and attitudes. The achievement data (pre-test and post-test scores) and attitude survey data were analyzed using descriptive statistics (mean, standard deviation) to summarize the results. The differences between pre-test and post-test scores for each group were analyzed using t-tests to assess significant changes in achievement within each group. The validity of the study is relatively strong due to the usage of pre/post test design. The generalizability of the findings was high owing to the large sample size that was used. Large sample sizes are more representative of the population and lead to more generalizable findings.

Research Study Five

The study "Effects of Virtual Laboratory experiments on Students' Academic Performance in Physics Practical" was conducted by authors Abdullahi et al., (2020) on 67 students in Nigeria. It investigated the effects of Virtual Laboratory Experiment (VLE) on senior secondary school students' academic performance in a Physics practical class.

The study made use of pre-test-post-test quasi experimental design with two levels of treatment and control group. The data collected were analyzed using descriptive statistics,

Analysis of Variance (ANOVA), Analysis of Covariance (ANCOVA) and t-test statistics. The internal validity of the study was strengthened by the pre-test/post-test design and control group design. The study's generalizability was limited by the sample size (67 students) which is not large enough to generalize the findings to a larger population, context (high school physics practical class), and specific virtual lab used. The findings of this study may be applicable specifically to the virtual lab platform used in this study, but the results may not be transferable to other types of virtual labs used for practical physics learning.

Conclusion

All the five studies focused on measuring the impact of virtual labs on student achievement, attitudes or scientific literacy and illustrate the diverse ways in which virtual labs can be integrated into science education. All the studies used descriptive statistics (mean, standard deviation). Four of the studies (Abdullahi et al., 2020, Ambusaidi et al., 2018, Lestari et al., 2023, and Tuysuz, 2010) employ pre-test and post-test assessments to evaluate the effects of virtual labs on academic performance or attitudes. Lestari et al., (2023) also used ANOVA to account for initial differences in students' scientific literacy, while other studies (Abdullahi et al., 2020, Ambusaidi et al., 2018, and Tuysuz, 2010) use t-tests to compare pre- and post-test scores. Kay et al. employs both quantitative (surveys) and qualitative (interviews) analysis.

In terms of research design, Kay et al., (2018) used a mixed-methods design, combining quantitative and qualitative data collection (surveys and interviews) to assess the impact of virtual labs in an allied health program. This provides a more comprehensive understanding of both the academic outcomes and student experiences. The other four studies were predominantly quantitative with experimental or quasi-experimental designs. Studies

employing quasi-experimental and experimental designs typically rely on quantitative data, whereas mixed method studies provide a richer, more nuanced view of the research problem.

The sample sizes varied significantly in the all the studies, with Kay et al., (2018), Ambusaidi et al., (2018), and Abdullahi et al., (2020) using a smaller sample (64, 69 and 67 respectively), while Lestari et al., (2023) and Tuysuz (2010) used a larger sample (102 and 341 respectively). Larger samples tend to provide more robust results, though smaller samples like in Kay et al., (2018) might allow for deeper qualitative insights.

Validity means "how well a test measures what it says it does" (Salkind & Frey, 2020). All the five studies have strong validity as they have made use of pre-test and post -tests designs. This can show whether any changes in the dependent variable are due to the intervention, rather than external factors. The study by Tuysuz (2010) has a stronger validity as it has used a randomized control group as opposed to the others that have non- random assignments.

A study can have high generalizability when its findings can be extended or applied to settings, populations, or situations beyond the specific sample or context being studied. Generalizability is higher for studies that have larger sample sizes. In the above five studies, Tuysuz (2010) and Lestari et al., (2023) have large sample size and have the highest generalizability, while studies with smaller sample sizes such as Ambusaidi et al., (2018), Abdullahi et al., (2020) and Kay et al.,(2018) have more context-specific insights but less generalizability. Additionally, because the studies were conducted in different parts of the world, including Indonesia, Canada, Oman, Turkey, and Nigeria, their generalizability is limited by their specific geographic locations.

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