Assignment Two: Research Paper Analysis

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The research conducted by Chittum et al. (2017) titled "The effects of an afterschool STEM program on students' motivation and engagement" questioned how an afterschool STEM (science, technology, engineering, and mathematics) program would affect students' motivation and beliefs towards STEM subjects in their present and future education. The two purposes of this study were to investigate how an afterschool STEM program, Studio STEM, affects students' beliefs about science and to investigate specific elements of the curriculum that would motivate students to engage in the program (Chittum et al., 2017). The research questions posed by Chittum et al. (2017) were "what extent do students' motivational beliefs about science change as a result of participating in Studio STEM" and "what aspects of the Studio STEM program affect students' motivation to engage in the curriculum" (Chittum et al., 2017).

During the Studio STEM program, students took part in the "Save the Penguins" and "Save the Seabirds" curriculum. The study was quasi-experimental because participation in the Studio STEM program (the intervention) was voluntary, so the assignment was not random. It was problem-based as it looked to solve the problem of student motivation towards science decreasing as students get older.

Having conducted a thoughtful and relevant review of existing literature relating to STEM topics and activities to form their research questions, Chittum et al. (2017) clearly explain that although research already exists to indicate afterschool STEM programs increase STEM knowledge of the students who participate, there is currently not much research relating to how these programs could also affect student motivation and engagement in STEM. This study is relevant and applicable to the education profession since Chittum et al. (2017) mention that motivation in science decreases as students grow older, which leads to less interest in STEM-related careers. The researchers used relevant and up-to-date information from the past decade, including research from as recent as 2017 and as early as the 1980s.

In terms of the design of the study conducted by Chittum et al. (2017), participatory action research was used as they were trying to improve an educational outcome by solving a problem (Suter, 2012). Specifically, Chittum et al. (2017) were trying to solve the issue of student motivation relating to science decreasing over time. Their usage of action research in the education field was proper and useful in answering the research questions in the study. A theoretical perspective was identified as Chittum et al. (2017) relied upon previous research. Some examples of these perspectives include students' interest in science declining as they grow older, needing to target student interests and motivation before the eighth grade, and that afterschool STEM programs can increase student knowledge (Chittum et al., 2017).

The researchers used expectancy-value theory and the MUSIC Model of Motivation as frameworks to guide their research (Chittum et al., 2017). According to expectancy-value theory, motivational beliefs directly affect students and, therefore, could have an impact on their perception of the Studio STEM program. The motivation-related constructs measured from expectancy-value theory included attainment value, interest value, utility value, and competence. The operational definition for these constructs was the students' self-rating of their beliefs on the science beliefs questionnaire using a 6-point Likert-type scale. The MUSIC Model of Motivation was used as it provides five distinct motivation-related constructs. The five constructs included empowerment/autonomy, usefulness/utility, success, interest, and caring. The operational definition for these constructs were the students' self-ratings on the Studio STEM/MUSIC Model of Academic Motivation inventory questionnaire.

Chittum et al. (2017) focused on using qualitative methods to cover various aspects of their research questions, but also included some quantitative methods which signals a mixed-methods approach. Qualitatively, one-on-one interviews were used to allow the researchers to gain clear and concise data with the opportunity to ask for participants to clarify their answers. Quantitative questionnaires were used which allowed the researchers to collect data to assess the motivation-related

constructs that would help to answer their research questions. Although these two methods were suitable for this research topic, Chittum et al. (2017) specifically mentioned competence to be an important factor of their study in relation to expectancy-value theory meaning this study would have benefited from a quantitative assessment of competence (i.e.test, quiz, or graded item). This would provide a more direct measurement of competence in comparison to a student self-reflecting on their competence in a questionnaire.

Specifically looking at the quantitative questionnaires of the study, the major construct was motivation, the quasi-independent variable was the Studio STEM program, and the dependent variables used were college plans, attainment value, interest value, utility value, and competence beliefs. Based on the information provided by the researchers, an alternative hypothesis could have been that motivation towards STEM subjects is positively affected by the style and emotions of the teacher leading the class. An extraneous variable that the researchers had to be aware of during the study was prior knowledge of STEM subjects, which could have affected the motivation of the students. The null hypothesis is that students' motivational beliefs towards science do not differ between STEM program participants and non-participants.

Chittum et al. (2017) conducted two convenience samples for their research. The first sample came from the quantitative questionnaire given to 102 fifth-seventh grade students who were present on both research days from two rural, low-income K-7 schools in Southwest Virginia and was used to answer the first research question. Data from the 19 fifth-seventh grade students who completed both the Save the Penguins and Save the Seabirds curriculum as part of the Studio STEM program was also collected from this sample. The second sample collected included the qualitative interview data and quantitative self-report data about Studio STEM from 14 students enrolled in the Save the Seabirds curriculum in Spring 2013 and was used to answer the second research question. Again, only students present on the date of data collection were included. Participants of this study were targeted to be in

fifth-seventh grade as it is believed that targeting student interests and motivation before the eighth grade is beneficial.

There are a few issues relating to sampling that could have impacted the results of this research. Both the longitudinal data from the first sample and the data from the second sample were small, consisting of 19 and 14 students respectively. Although Chittum et al. (2017) believed that their sample size was sufficient due to their concentration on qualitative methods, it is then difficult to take their quantitative findings with the same importance. With the participants coming from two rural, low-income schools, external factors such as access to STEM resources and other technology that would allow students to embrace STEM subjects outside of school could be at play. Being exposed to STEM outside of the classroom could impact student motivation, and if motivation was a primary factor in this study, then this is a factor that must be noted due to the social status of the participants. For ethics reasons, parental and student consents were obtained for students to participate in this program, meaning students that may have wanted to participate were unable to which could have introduced bias in the sample. Additionally, selection bias was likely present as noted by Chittum et al. (2017), due to allowing teachers to recommend students for participation in the study. Teachers may have only recommended the program to participants who were already interested in STEM subjects, and therefore, already were motivated to pursue a career in STEM.

In terms of data collection, if Chittum et al. (2017) were interested in the construct of motivation relating to science then expectancy/competence and achievement are important factors and not sufficiently included through questionnaires and interviews. Although these factors are covered in the MUSIC Model of Motivation, a measurable and comparable quantitative result representing student achievement, such as an assessment, is missing from this study. The role of the researcher is well explained in the study as they were not part of the teaching of Studio STEM and only in data collection and analysis. Descriptive clarity relating to data collection was given as interviews were conducted

during the second-to-last session of the program and the questionnaires were collected during school hours in December 2011 and May 2013. Researchers beginning each interview by showing a listed summary of things that had happened during the Studio STEM program could have also introduced recency bias. Depending on the specifics included or missing in this summary, student responses could have been impacted.

For the questionnaires used in the school-wide data analysis, Chittum et al. (2017) ran two independent samples *t* tests to compare Studio STEM participants and non-participants at the two data collection points. The change over time of both the STEM participants and non-participants was measured with separate paired-samples *t* tests. The researchers used a significance level of .05 for all *t* tests. For the interviews and questionnaires used in the specific Studio STEM data analysis, they formed descriptive statistics for the questionnaire data and transcribed the recorded interviews verbatim (Chittum et al., 2017). To ensure reliability and validity, the data was then coded by two authors independently using five categories relating to the five MUSIC model components and then the researchers compared their findings.

The overall rigour of the study conforms with three of the four components of trustworthiness including credibility by using quotes from students in the research paper and by requesting feedback from students. It also conforms with transferability by using previous research to determine their population target to make certain that their findings would be able to be replicated in other settings and with dependability by using the appropriate level of detail when providing reasoning for decision making and steps in the completion of their research. A bias could have occurred during the interview process of data collection potentially impacting confirmability. It is not clearly known exactly what was included in the listed summary of the presentations, activities, and demonstrations during the Studio STEM program. The researchers' opinion of what should or should not have been included in the summary could have affected answers to the interview questions.

The researchers explained the overall findings of the study through tables and graphs that provided data to help answer both research questions (Chittum et al., 2017). These tables compared Studio STEM participants and non-participants regarding their college plans, attainment value, interest value, utility value, and competence beliefs. The study's findings were impactful and useful in the field of education and were broken down to conform with the MUSIC Model of Motivation. The researchers concluded that Studio STEM positively impacted the participants' motivational beliefs about science and their plans to go to college. They also concluded that the motivational beliefs about science and intentions to pursue a college degree were more resilient in Studio STEM participants than non-participants. Based on the research questions and the interpretation of the data collected, I do think the conclusions given by the researchers were appropriate.

The researchers proposed that based on their findings, it is recommended to offer students the ability to join a problem-based program such as Studio STEM to encourage students to pursue STEM based careers (Chittum et al., 2017). Exposing students to STEM subjects in a motivating way, it could help solve the documented decline in student motivation towards science as they age. The weaknesses and limitations of this study included the lack of a quantitative assessment, a possible selection bias due to teacher involvement and the need to conform with ethics, the sample size, and the lack of details regarding the Studio STEM summary. The researchers also asked for feedback on their study and the Studio STEM program to try to make the program even more exciting for students to raise motivation. This study benefits researchers, teachers, and students as the conclusions and recommendations can help provide fun and exciting opportunities to learn about STEM subjects, and maybe one day, inspire a student to pursue a career in the STEM field.

References

Chittum, J. R., Jones, B. D., Akalin, S., & Schram, Á B. (2017). The effects of an afterschool STEM program on students' motivation and engagement. *International Journal of STEM Education, 4*(1), 11. https://doi.org/10.1186/s40594-017-0065-4

Suter, W. N. (2012). *Introduction to educational research: A critical thinking approach* (2nd ed.). SAGE Publications, Inc. https://www.doi.org/10.4135/9781483384443

Peer Review

The feedback I received and implemented was beneficial to my paper. It was suggested to be a bit clearer in letting the reader know if the study was more focused on the quantitative or qualitative methods. The confusing came from implying the findings were only presented in tables and graphs. For this suggestion, I edited the sentence introducing the mixed-methods approach to signal that it was more qualitatively focused. It was also suggested to mention that the parental and student consents are necessary to conform with ethics, even if it is creating a bias. Again, I changed the sentence introducing this weakness to mention that it would be necessary for ethical reasons. A summary of weaknesses and limitations of the research paper was also suggestion which I did implement in the concluding paragraph. Finally, I implemented the grammar suggestions that fit my own writing style which were suggested by my peers.