Canadian Journal of Educational and Social Studies
Vol. 5(3), 2025, pp. 1-14

Integration of Trades-Based STEM Education in Canadian K-12 Schools

Joshua Hill[1] & Anna Liberty[2]

[1,2] Lethbridge Polytechnic, Canada
Correspondence: Joshua Hill, Lethbridge Polytechnic, Canada
Email: tradeseducation1st@gmail.com; annae.liberty@gmail.com

DOI: 10.53103/cjess.v5i3.342

Abstract

Demand for skilled trades occupations in Alberta has steadily increased, coinciding with a decade-high youth unemployment rate. Addressing this challenge, this study evaluates the effectiveness of trades-based STEM kits in enhancing Canadian K-12 students' retention of STEM knowledge and fostering interest in skilled trades careers. By addressing a gap in practical, hands-on learning opportunities, the research explores whether participation in STEM kit activities improves students' understanding of STEM concepts and influences their career aspirations. Surveys were administered to students from kindergarten to grade six, in two formats: Group or Individual. Results indicating significant STEM concept retention and a majority of students expressing enjoyment and willingness to engage in similar activities in the future. The initiative was also found to be statistically significant in affecting career aspirations. Thematic analysis of feedback highlighted the benefits of interactive, practical learning while also identifying logistical challenges. These findings suggest that trades-based STEM kits are a valuable educational tool that not only support STEM learning outcomes but also encourage youth to consider careers in the skilled trades.

Keywords: STEM Curriculum, Vocational Education, Perception

Introduction

According to a recent article in *The Hill Times*, the unemployment rate of young people in Canada has reached the highest it's been in a decade –excluding the pandemic years– (Mohamed, 2024). An article written by Decaire and released by CBC news states "Students urged to go into trades as industry faces labor shortages", explaining that the disinterest with trades careers has actually persisted for a few decades (2021). This is an issue now as many of the skilled laborers are ready for retirement with insufficient numbers to replace them. With such a high unemployment rate, the trades professions may become strained due to lack of employment and engagement with younger generations. According

to Statistics Canada (2024) job vacancies within the "trades, transport, and equipment operators" category are around 98,400 and have grown by 85% (Business Council of Alberta, n.d.). These positions predominantly require candidates with specialized trade or apprenticeship credentials, underscoring a critical shortage in a key sector of the economy. Although there are many vacancies, these career paths are not pursued by the unemployed youth. Why? Studies by Ochiba et al. (2022) and Ostadalimakhmalbaf et al. (2021) reveal contrasting perceptions of the construction industry, highlighting the impact of exposure and misinformation on career choices. Specifically, vocational education and training (VET) suffers from a lack of social prestige which leads families' and teachers to discourage their youth from pursuing a career in an industry that has many career options (Abrassart & Wolter, 2020; Zeb, Ali, & Ullah, 2021).

Educational systems play a significant role in career and education choice as found by Clarke & Polesel (2013). They found that secondary students in Australia choose courses that lack academic depth and hedge their bets when choosing courses in school to favor a higher tertiary entrance credentials and scores (Clarke & Polesel, 2013). This means they may not take all of the coursework that would benefit them in either a Vocational Trade or Academic path because the connection is not clearly outlined. Furthermore, students often ask the question of "Why do we need to learn *this*?" creating contempt to learn some topics over others when practical application is not apparent.

Our research aims to address these gaps in knowledge. The current study elucidates students' reception and perception of skilled trades STEM kits as an educational tool. Furthermore, we investigate the correlation between exposure to skilled trades STEM kits and thinking about choosing a skilled trade as a career option before and after use of STEM kits.

Specifically, we asked the questions: Do students who use trades-based STEM kits claim to remember the STEM information better? And, after using trades-based STEM kits do students increase their desire to work in a skilled trade occupation? We hypothesized that students who use trades-based STEM kits will report better retention of STEM information. We also hypothesize that students' reported desire to work in a skilled trade will increase after using trades-based STEM kits compared to before using these kits.

Methods

Surveys were developed with the assistance of teachers who are familiar with the developmental ages and understanding for those who the surveys are intended for. One survey was designed for students from kindergarten to grade six. The second survey was designed for grades seven to twelve. Surveys were distributed to students who have been exposed to at least one of the STEM teaching tools (kits) within the past 6 months and preferably within the past 2 weeks. Two additional surveys were created to elucidate the

attitudes and perceptions of teachers towards the teaching kits after first learning about the kits and another for after they had used them in the classroom.

The ethical guidelines and considerations as outlined from https://childethics.com/ and as suggested by Wolfenden et al. (2009). We obtained divisional support for all of the school districts before or during the data collection process. We also obtained the consent of the principal for which school the students were from. Then the consent of the parents and finally consent of the students was obtained. We also obtained the permission of teachers but did not formally record this permission. Consent forms were translated into English, Spanish, Urdu, Arabic, and Somali. To protect anonymity and confidentiality, students were given a randomly assigned number on the parental consent form and to participate in the survey the students input that ID number to consent and were then allowed to participate. The student names were not used on the survey and any other identifying demographic information was kept to a minimum.

Consent forms for principals were obtained in person or online. Consent forms for parents were obtained online (or hard copy depending on the divisional rules) and all surveys distributed were conducted online.

The students took the surveys during school hours at the direction of the teacher. Students who did not return a consent form were not permitted to take the survey. Students who did not finish or only partially finished the survey did not receive any penalty. A group survey was created for those teachers who thought their student body would be best surveyed as a group. This could be due to teachers' perception of students' reading level, convenience, or due to time constraints. Questions remained the same but group counts were created in the questionnaire so the teacher could administer a "show of hands" approach. Qualitative data from these samples will be discussed separately from the individual survey results.

Once the data was collected, the data was reviewed for completeness and descriptive statistics where completed. A comparison of the different survey groups was evaluated followed by a thematic analysis of the data. The thematic analysis used the themes elucidated from the study.

Results

Student participants from the individual survey analysis were in grades four (44.6%), five (15.8%) and six (37.6%) with only 1% being from grade one and 1% being from grade three. This does not include the 39 students from grade 2 (51%) and grade 5 (49%) that took the survey as a group. We will discuss those data separately. For students age and ethnicity was not taken to help further preserve anonymity. More students reported being male (50%) than female (46.9%) with 2% that did not say and 1% identifying as "other". When asked which "Which Trades Kits did you Use" most students reported using

multiple kits with the Angles, Wind Turbine and Carpentry accounting for the majority of the experience's students were having (see Figure 1).

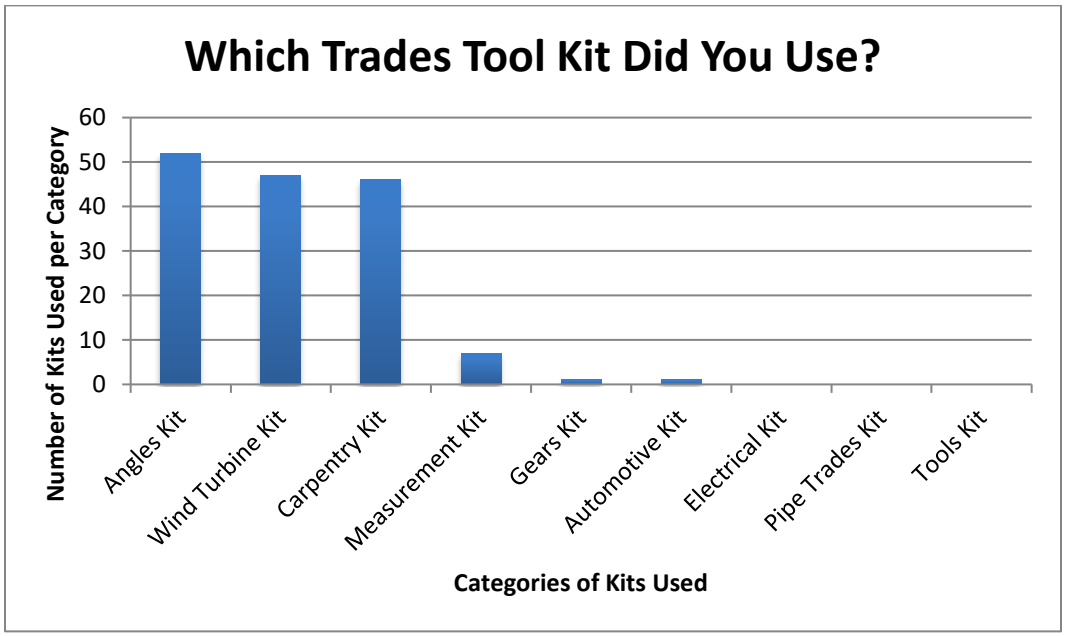

Figure 1: Frequency of trades tool kit usage by category

Note. N=105* some students have access to more than one kit

Examining the difference between grades and the student's response to "Do you remember what you learned from this activity", there was no statistical difference between grade level and retention of information for the individual response sets. The majority of students reported that they remembered what they had learned with this activity (see Figure 2). In the group setting, 65% percent of students who took the group survey within a week after the activity reported remembering what they learned from the activity while 20% of the students who took the survey a month after the activity reported remembering what they had learned.

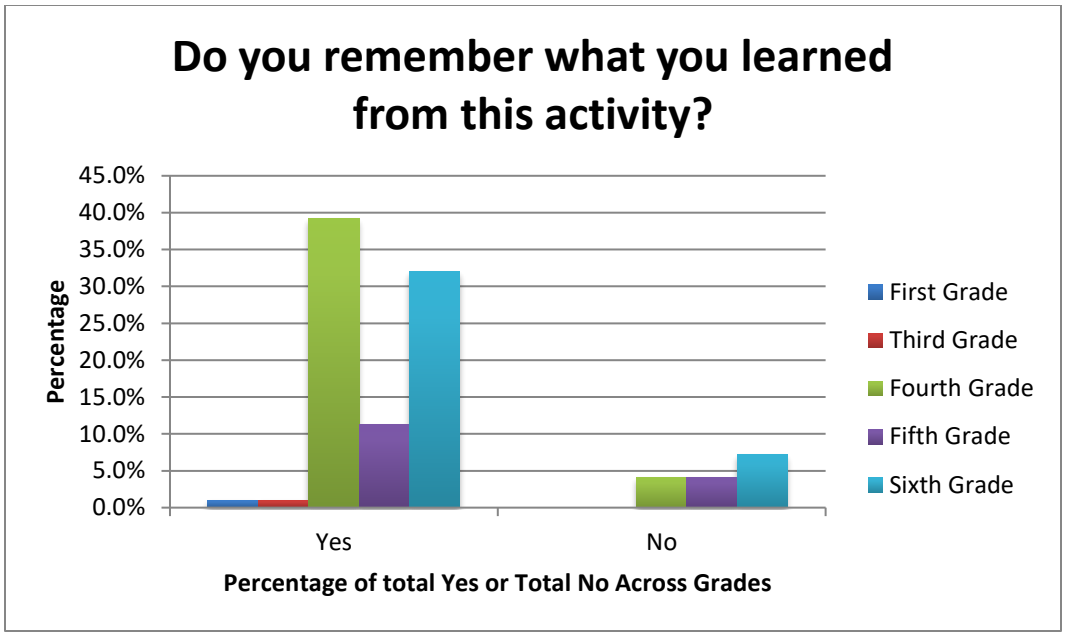

Figure 2: Self-Reported remembrance of what students learned with the activity(s)

Note. n=105 Students were asked if the remembered what they had learned (k-6) shortly (within a week) after they did the activity. There is no statistical difference between grade and retention of information (x^2 (4, N=97) =3.19, *p=0.526, Cramers's Vl phi =0.181)*.

Almost all of the k-6 students who took the survey individually (98%) reported that they would like to do something like this again and reported that the activity was fun (99%). Similar results were seen with the k-6 group cohort where 85% reported they would like to do something like this again and 82.5% reported that the activity was fun (n=39). The group cohorts were only exposed to the wind turbine kits. Students in the group response setting who were part of the 5th grade reported lower retention (20% affirmative) than the 2nd grade group (80% affirmative) when asked "Do you remember what you learned from this activity". This will be discussed later. When comparing student responses to the question "before this activity, did you want to work in trades jobs like these when you grow up?" to "after this activity, did you want to work in trades jobs like these when you grow up?" it was found that the group response data collection set had an increase from 12.5% to 25% in the affirmative and the single response data collection set saw a significant increase ($p<0.001$, R^2:0.263, AIC_c: 98.3) from 28.8% to 48.5% in the affirmative.

Thematic Analysis

Starting with the k-6 individual dataset the themes that were identified include, "Learning, Discovery and Exploration", "General Enjoyment", "Hands on (build, make, craft, test)", "Specific Enjoyment", "I don't know". Statements such as "Learning about measurement and angles" would fit under "Learning, Discovery and Exploration. Statements such as "it was fun and cool" would fall under "General Enjoyment". Statements such as "I liked how we got to see how much energy we made" fell under "Specific Enjoyment". Statements such as "Cutting out the blades was fun! Testing the blades with the fan was so cool! Turning on the fan! Decorating the blades! Picking the angle numbers!" Would fall under all categories. Mentions within these themes were examined and a percentage of total mentions was compared (see Figure 3).

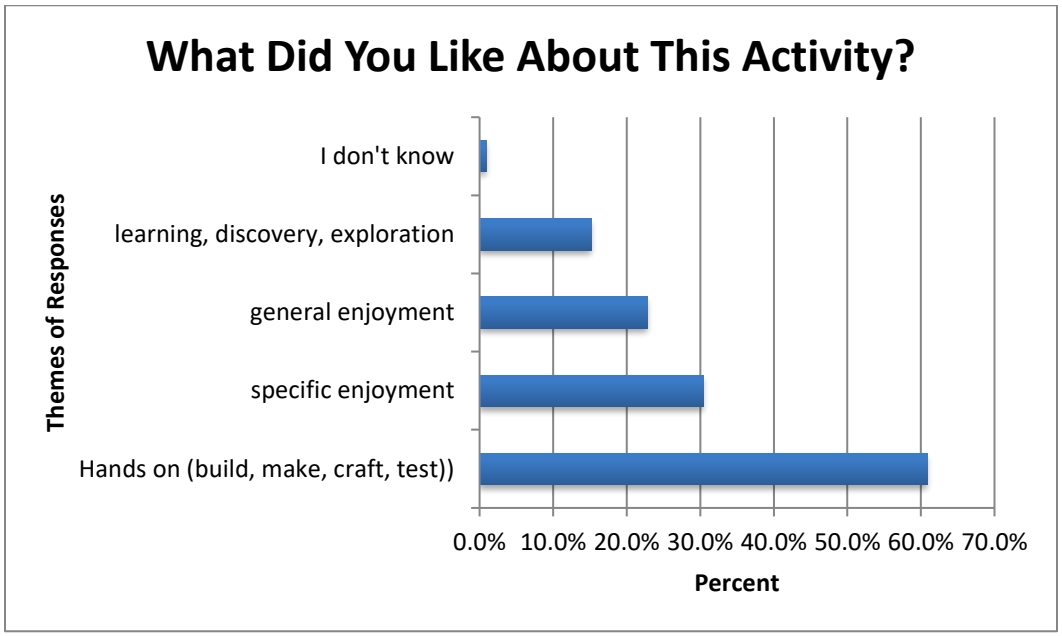

Figure 3: Themes from "What did you like about this activity?"

Note. n=105* some responses fall under more than one category

When asked what could have made the activity better and the categories were broken down into "No Improvement Needed", "Product Complaint", "Process Complaint", and "Uncertainty in Response". The number of mentions per category were tabulated (see Figure 4). Statements fall under the "No Improvement Needed" if they reported phrases such as "nothing", "it is fun that I get to build and test, measuring…". Statements that were

categorized as a "Product Complaint" include "if they brought a planer and we got to use real wood" or "if the wood didn't snap". A "Process Complaint" includes "if we chose *our* group". "Uncertainty in Response" would include "I don't know".

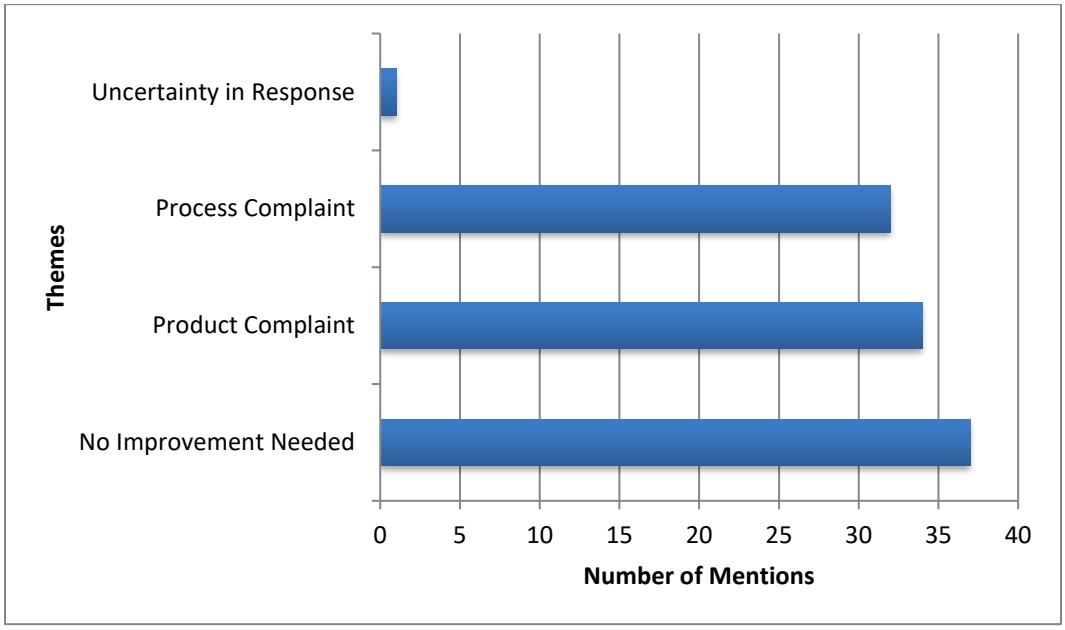

Figure 4: Themes "What could have made this activity better?"

Note. n=102 Some student responses are reported in more than one category.

Students were asked to report on their learning outcomes from the activity. Thematic analysis revealed the following themes: angles (41 mentions), e.g., "…when you get a smaller angle, it catches more wind…"; practical skills and safety (39 mentions), e.g., "how to cut"; windmill/general mechanics and functionality (28 mentions), e.g., "I used a 30-degree angle for the windmill"; energy generation (14 mentions), e.g., "I learned that lighter materials are easier to spin and make more electricity"; learning and knowledge (14 mentions), e.g., "I learned how to make the wind turbine work"; and forgetting (2 mentions), e.g., "I forget." The frequency of these themes was tabulated and is presented in Figure 5.

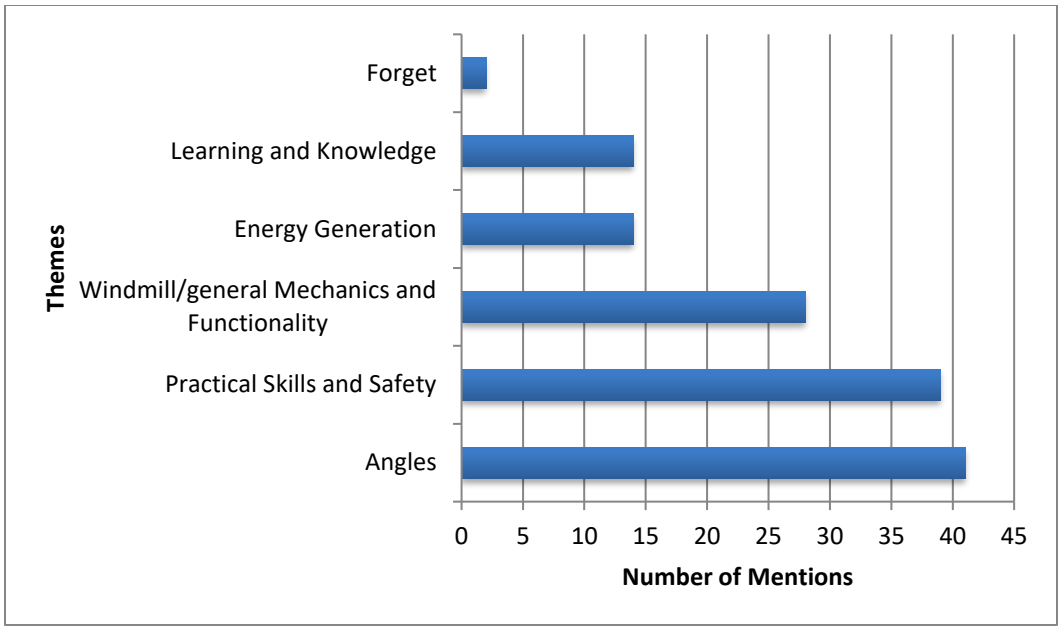

Figure 5: Themes from "Draw or Write what you learned from this activity."

Note. n=105

When comparing the types of kits to the level and type of dislike or improvement mentioned, it was found that the theme of "No Improvement" was mentioned 53.5% of the time for Carpentry, 49% of the time for Angles, 43% of the time for Measurement, and 20% of the time for Wind Turbine. "Process complaints" were mentioned 19% of the time for Carpentry, 22% of the time for Angles, 28% of the time for Measurement, and 40% of the time for Wind Turbine. For "Product complaints", 28% of the time for Carpentry, 30% of the time for Angles, 28% of the time for Measurement, and 40% of the time for Wind Turbine (see Figure 6).

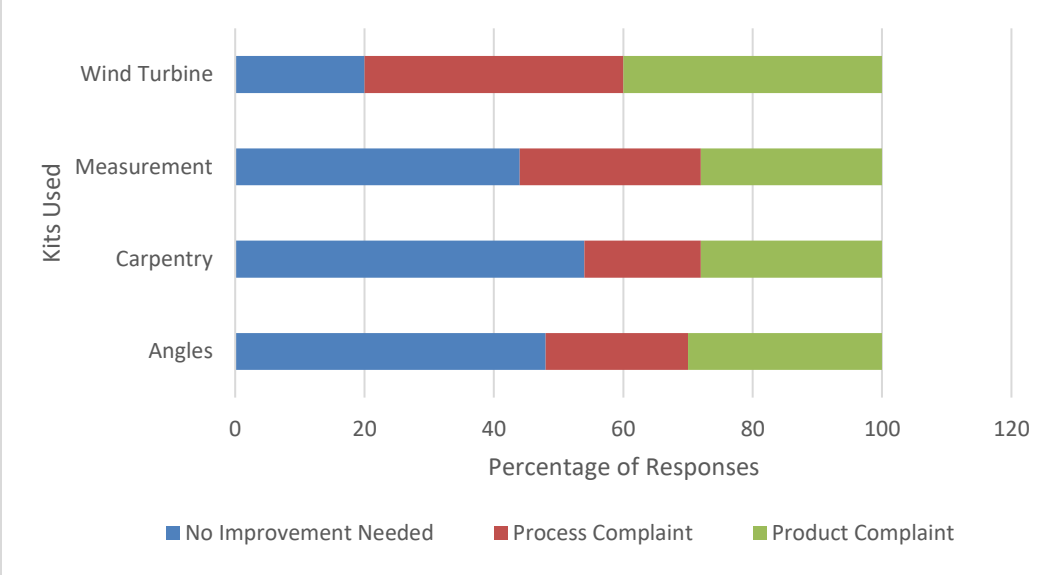

Figure 6: Comparison of kit types and the themes of dislike or improvement

Note. n=105. Angles kit received had 49 responses. Carpentry kit received 54 responses. Measurement kit received 7 responses. Wind Turbine kit received 45 responses. Each percentage is based on the individual kit percentage of responses.

Discussion

The analysis provides valuable insights into elementary student's perceptions and experiences with trades-related educational kits. The distribution of students from grades four, five, and six, with smaller representation from grades one and three, suggests the target engagement primarily reached upper elementary students. While the omission of age and ethnicity data preserved anonymity, this limited the analysis regarding potential demographic influences on engagement or outcomes. The popularity of the Angles, Wind Turbine, and Carpentry kits highlights student preference for hands-on, engaging, and moderately paced activities. The vast majority of students reported positive experiences with the negative feedback of having to wait their turn, or supply issues (because they broke their item). These negative points of feedback are simple to address which means that the students experience can be easily enhanced. Some students had the opportunity to engage with many kits over a short period of time. These students had a greatly enhanced experience, if time was available, because they were able to experience multiple trades in one session. Although not all kits were represented, the kits that were reviewed have provided a substantial backdrop for the reception of teaching with trades-based STEM kits.

Students reported a relatively high percentage of "No Improvement Needed" responses for Carpentry and Angles kits which implies strong satisfaction. Conversely, the Wind Turbine Kit obtained more "process" and "product" complaints indicating the need to review the delivery of that kit and make some refinements. Overall, when reviewing data, students had clever suggestions of improvement that revolved around the "process" and "product". There are aspects of the process, such as picking their own groups, that are preferred as well as parts of the product, such as blades that wouldn't snap, that would make their experience better. That group; however, did have an overwhelming positive response to the seemingly negative question (Figure 6). Once again, this suggests that there can be some minor changes made to the delivery method such as to have more materials available, so students do not need to wait in a line or allowing the students more time with the materials but overall, the current way the kits are being delivered is sufficient for the needs of most students.

Do students who use trades-based STEM kits claim to remember the STEM information better? As noted in Figure 2, most students reported remembering why they needed to learn the topic and how the activity tied to the learning. Although the statistical analysis indicated that there was no significant difference between grade level and retention of information, the group data did reveal that retention does decline over a month. This is consistent with Ebbinghaus's forgetting curve (Yu et al., 2018). Further research will explore the extent to which students can retain this information and if the tipping point of this curve is delayed by the trades-based stem activities.

Reportedly, students gained an appreciation for the exploratory nature of the activities and the knowledge they had gained. With the majority (98%) reporting that they would like to do something like this again, these types of activities need to be expanded for the benefit of the student's joy of learning. Other researchers have found that students who are permitted to explore the "why" of learning with practical application and hands on experience perform better than those who do not (Owolabi et al., 2024). Further research needs to be conducted to complete a comparative analysis for students who do receive this additional type of instruction (via STEM kits) and those who do not for this project. Furthermore, students who are going to want to pursue these fields of work and study should be tested practically and not just theoretically. A practical exam of these skills could challenge participants with formative assessments and skills-based learning assessments completed through observation (similar to the Dual-Credit Courses offered by some institutions). With student feedback focusing on the themes of learning and knowledge as a source of enjoyment and a key "take away" for the students, these data confirm that the focus of the activity is not just for fun but brings value to the curriculum that it serves.

The application to real life and career aspirations is of particular importance. Oman, Pandey, & Gaddam (2022) found that practical based learning has significant effect on employability due to the preparation that it gives to learners. When answering the

question, “After using trades-based STEM kits do students increase their desire to work in a skilled trade occupation?” we also hypothesized that students' reported desire to work in a skilled trade will increase after using trades-based STEM kits compared to before using these kits. As predicted, it was found that student perception and desire for a career in trades significantly increased after exposure to the STEM kits. Having 30% of students before and 50% of students after the activity answer YES to the question of “…did you want to work in trades jobs like these when you grow up?” is a significant and meaningful increase. If governments and education systems aim to build a growing body of youth with the skills to tackle the jobs that will be available to them, then focus needs to be put on the work done by skilled trades. The trades-based STEM kits provide a meaningful avenue by which students can gain some of that preparation. Unfortunately, as educational institutions try to fulfil the needs of students, it is becoming increasingly difficult to do so due to funding limitations. As a result, it is necessary to try and engage student populations utilizing all of the available resources within the education network. Sharing of resources, therefore, will increase the educational experience of the primary and secondary students if the resources that already exist in colleges and polytechnics can be made available through efficient supply channels.

Lastly, with the aim to understand the perception society has towards skilled trades, the trades-based STEM kits can provide a means by which students can assess the skilled trades for themselves by gaining positive exposure to those trades. Future research could look at the relationship between teacher perspectives on skilled trades STEM kits in class and student perspective on skilled trades careers (Zeb, 2021). It would be beneficial to also survey students on their dream jobs in the future and implement curriculum based on aspirations that include STEM-inspired careers. There could be lack of interest due to lack of knowledge of future careers. In a study done in 2015 (Fatherly), there were many reports of students who did not know what they wanted to be and who did not know what their parents did for work. The article also suggested that there could be a recency effect in the aspirations of children for their future careers which would suggest that early and consistent introduction of STEM activities and curriculum would be beneficial for shaping the interests of the future workforce. Furthermore, more longitudinal work will need to be done to understand the relationship between the student's perception in a k-6 setting and actual career outcomes.

Limitations and Directions for Further Research

Students expressed fewer positive perceptions of the wind turbine kit activity when compared to the others. For those delivering the kits it is important to allow appropriate amount of time for students to engage with the kits in order for the kits to have the greatest effect on learning and retention of information. It has been suggested in previous research

that an implementation of modules for STEM education would be beneficial for students' retention and interest (Hudson et al., 2015). For instance, the study conducted by Hudson et al. (2015) explored the results of implementing a three year project called "Developing engineering education in primary", also referred to as the DEEP project, which focused on the pedagogical practices of STEM education to students in Australia, suggesting the importance of how the education is delivered may be key to the success of students, which supports the results of this study that reported some of the main problems students have with the STEM kits had to do with processes and products.

The structure of the questions in the survey where students were asked "Before (or After) this activity, did you want to work one of these jobs?" could be limited by the careers represented in the picture, and the student's ability to imagine beyond the picture. Some students may have been able to imagine beyond the careers represented in the picture, but some would have been primed to only see and think of those jobs depending on their developmental state. This could have skewed the results.

There has been some research done on introducing modules as a way to introduce STEM topics within regular curriculum that has yielded similar results ending in more positive attitudes towards STEM-based activities within primary schooling (Shahali et al. 2017). More research can be done within primary and secondary schooling that implements modules that focus on STEM integration while exploring the effect of early introduction and consistent implementation of STEM activities within the school's curriculum. Shahali et al. (2017) also suggested that early introduction can be key to engaging the interests of young students; however, there has been no research on what grade level has been most effective at encouraging ongoing interests.

There are many recent studies that focus on the teaching aspect of these STEM education programs; it has been suggested that a successful way to make a lasting impact on younger students would be to inspire play and creativity within the students (Campbell et al., 2018). This would highlight the importance of surveying the students prior in their interests and understanding of STEM careers and then implementing curriculum either based on or inspired by the results of the survey. This would shift the importance from simply the delivery of the program to inspiring success and interest from students. It is important to consider the pedagogical side of the discussion; however, there has been far less research with the topic of students' initial interests and building education based on the existing framework they have.

References

Aurelien, Abrassart., Stefan, C., Wolter. (2020). Investigating the image deficit of vocational education and training: Occupational prestige ranking depending on the educational requirements and the skill content of occupations. *Journal of*

European Social Policy, 30(2), 225-240. https://doi.org/10.25384/SAGE.C.4643861.V1

Business Council of Alberta. (n.d.). Stretched thin: Labour supply in the skilled trades. Retrieved January 14, 2025, from https://businesscouncilab.com/reports-category/task-force-policy-reports/stretched-thin-labour-supply-in-the-skilled-trades

Campbell, C., Speldewinde, C., Howitt, C., MacDonald, A. (2018). Stem practice in the early years. *Creative Education*. 9(1). https://doi.org/10.4236/ce.2018.91002

Clarke, K., & Polesel, J. (2013). Strong on retention, weak on outcomes: the impact of vocational education and training in schools. *Discourse: Studies in The Cultural Politics of Education*, *34*(2), 259-273. https://doi.org/10.1080/01596306.2013.770251

Decaire, C. (2021). *Students urged to go into trades as industry faces labour shortage.* CBC News. Retrieved on Feb 20, 2025. Retrieved from: https://www.cbc.ca/news/canada/ottawa/students-urged-to-go-into-trades-as-industry-faces-labour-shortage-1.6165774

Eurich, N.P. (1993). Knowledge applied: The real commencement for high school students. *NASSP Bulletin, 77*(552):77-80. https://doi.org/10.1177/019263659307755212

Fatherly. (2015, November 18) *This is what kids want to be when they grow up.* Fatherly. Retrieved February 19, 2025, from https://www.fatherly.com/news/what-kids-want-to-be-when-they-grow-up

David, H., & Kim. (2023). Educational interventions involving physical manipulatives for improving children's learning and development: A scoping review. *Review of education, 11*(2). https://doi.org/10.1002/rev3.3400

Mohamed, F. (2024, November 25). *Canada's youth unemployment crisis is an $18.5 billion dollar opportunity*. The King's Trust Canada. Retrieved January 11, 2025, from https://www.kingstrust.ca/canadas-youth-unemployment-crisis-is-an-18-5-billion-dollar-opportunity/

Ochiba, D. & Afolabi, A. & Oleah, C. & Osoaku, F. (2022). Generation Z perception of skilled labor trades in the construction sector. *AIP Conference Proceedings. 2437*(1). 020140. 10.1063/5.0109283.

Oman, Z. U., Pandey, S., & Gaddam, A. (2022). A study on impact of conceptual and practical based learning on employability. *World Journal of Advanced Research and Reviews*, *16*(2), 486-492. https://doi.org/10.30574/wjarr.2022.16.2.1204

Ostadalimakhmalbaf, Mohammadreza & Escamilla, Edelmiro & Pariafsai, Fatemeh & Saseendran, Anusree & Dixit, Manish. (2021). Perceptions of Skilled Trade Students on Factors Impacting the Decision to Pursue a Construction Career. *EPIC Series in Built Environment*, *2*, 524-514. https://doi.org/10.29007/x52h.

Statistics Canada. (2024, December 16). *Job vacancies, third quarter 2024*. Retrieved January 11, 2025, from https://www150.statcan.gc.ca/n1/daily-quotidien/241216/dq241216a-eng.htm

Trimmer, K., Donovan, J., Flegg, N. (2020). *Educational Innovation: Challenges of Conducting and Applying Research in Schools*. In: Donovan, J., Trimmer, K., Flegg, N. (eds) *Curriculum, Schooling and Applied Research. Palgrave Studies in Education Research Methods*. Palgrave Macmillan, Cham. 1-17. https://doi.org/10.1007/978-3-030-48822-2_1

Yu, H., Liu, Z., & Wu, J. (2018). Forgetting in order to Remember Better. *arXiv: Neurons and Cognition*. https://arxiv.org/pdf/1812.05668.pdf

Zeb, A., Ali, A., & Ullah, A. (2021). The role of teachers in career guidance of students at secondary level in Pakistan. *Journal of Social Sciences Review, 1(2),* 26-37.