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Educational Technology & Design

Trades with Distance Education

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Abstract

The pandemic underscored the critical need for skilled tradespeople in Saskatchewan, with a significant portion nearing retirement. This urgent need for skilled workers is a call to action for all educators, policymakers, and researchers in technical and vocational education. High school technical and vocational courses are essential for sparking interest and providing foundational skills in trades such as automotive repair, welding, and construction. The introduction of virtual reality (VR) and augmented reality (AR) in education can bridge the gap caused by the pandemic, offering immersive, practical training experiences. Studies show that VR training is effective, cost-efficient, and reduces training time, while AR provides real-time support, albeit at a higher cost. Future research should focus on implementing VR and AR in high school technical education to address the growing demand for skilled workers.

Keywords: distance education, tech ed, virtual reality, augmented reality, online training, vocational education, tech/voc

Vignette: Rodney's Welding Class

Rodney's welding classes are halted due to the shutdown of school classrooms as a result of the COVID-19 pandemic. Without being able to allow students to work in a controlled shop environment, students interested in developing skills as a welder are denied practice time and instruction. Rodney has been creating a virtual reality (VR) system that allows users to create welds virtually, see differences between good and bad welds, and receive feedback from a virtual instructor on the quality of their welds and tips on improving. By providing this program to students and renting equipment to families, students are encouraged to practice at home. The program also provides Rodney with assessment tools to grade student performance and progress. When the students return to school, their skills have progressed, and they see greater success in the more challenging upper-grade level rather than having to relearn the lower-level skills in the classroom.

Vignette: Alex's Mechanical and Automotive Class

Alex's grade 11 Mechanical and Automotive class is starting its unit on automotive maintenance. Their grade will be based on their individual performance of safe, thorough, and correct procedural inspections. However, the class size of twenty is too large for Alex to safely demonstrate the proper procedures and tool usage with all the students in the shop setting. Alex has decided to incorporate VR stations for half of the class while the other half receives a real-life demonstration of the maintenance procedure. In the following class, the student groups will switch the demonstration method. Therefore, the entire class utilize both VR and real-life demonstrations to understand the correct procedure for vehicle maintenance. Furthermore, students who miss a day can still utilize the VR system when they return. Using this method, Alex can ascertain the student's comprehension of the service procedure and safe execution by reviewing the grading system provided by the VR program and be more confident in allowing students to work on customer vehicles.

Introduction

Skilled trades in Saskatchewan are rapidly approaching a critical juncture. Weikle (2024) stated in a report through the Canadian Broadcast Corporation that a staggering 700,000 skilled tradespeople are set to retire by 2030. The current replacement rate is far from sufficient, underscoring the urgent need for action. However, there is a potential for growth in these numbers in the form of high school technical/vocational (tech/voc) courses. These courses are not attempts to meet the demand but rather to create interest in the trades among youth, potentially ushering in a new generation of skilled workers. Tech/Voc or trades education equips students with the necessary skills for the

manufacturing, repair, and service industries. Fostering student interest in the trades is of paramount importance. Without the trade and service sectors, many of the products our society relies on will become prohibitively expensive and difficult to repair. The COVID-19 lockdown temporarily halted technical/vocational education, primarily due to the need for hands-on training. This practical training is crucial, as it provides invaluable experience, builds confidence, and simulates real-world situations in a controlled environment to develop the necessary skills. Some Practical and Applied Arts (PAA) skill areas include Automotive Repair, Welding, Construction, Commercial Cooking, and Hairstyling/Aesthetics.

Distance education, in the context of this paper, refers to any form of learning that takes place outside the traditional classroom setting. This can include online learning, correspondence courses, or even hands-on training that is conducted remotely. The roots of long-distance education can be traced back to 1873 in the United States with the "*The Society to Encourage Studies at Home*" (Pregowska et al., 2021, p. 3). Similarly, in Canada, as early as 1889, McGill University utilized correspondence to "provide degree opportunities for rural teachers who were unable to attend [university] full time." (Haughey, 2013, para. 3). This historical context not only underscores the resilience and adaptability of education but also highlights its evolution in the face of geographical and technological barriers.

Since then, technology has advanced, and so has distance education. 2020 brought online learning to the forefront of distance education. The COVID-19 pandemic forced school closures and distance precautions to be maintained. A mixture of synchronous and asynchronous methods were used during this frenzy of online learning classes. Asynchronous methods are more analogous to the correspondence of the past. Teachers and students do not meet; lessons are pre-recorded, audio or visual, and assignments and instructions are provided in writing. The synchronous class "requires interactions in real-time, such as listening to live radio programs or attending live online lectures" (Pregowska et al., 2021, p. 1).

Guiding Questions

- What technical or trade education is provided online?
- Where can educators find suitable training for implementing distance education?
- How can AR and VR learning enhance distance and online education programs?
- Is the online training for TechEd substantial enough to provide learners with the skills to begin a career in a selected field?

Literature Review

The 2021 Census of Canada reported in the Saskatchewan Education Report that only 10.9 percent of Saskatchewan's population between the ages of 25 and 64 obtained an apprenticeship or a trade certificate (Government of Canada, Statistics Canada, 2022). Saskatchewan's education statistics saw a dramatic shift from 2016 to 2020, when the number of citizens with bachelor's degrees increased by 3.3 percent.

> The total number of working-age people with apprenticeships declined in mechanic and repair technologies [auto mechanics] (-7.8%) and precision production [welding] (-10.0%) from 2016 to 2021 and stayed relatively level in the construction trades [carpenters, electricians, and plumbers] (+0.6%), as the number of younger entrants could not replace those retiring quickly enough (Government of Canada, 2022).

The numbers indicate that now, more than ever, students need to be introduced and inspired to seek a career in the trades. *Immigration, Refugees, and Citizenship Canada* even allow fast-tracking of applicants who can offer skilled trades. Of Saskatchewan's top 10 most in-demand jobs, five are related to skilled trades (Risdon, 2024). The demand for more training, greater access to training, and distance tech/voc education is growing. In its 2023 report, the Provincial Auditor of Saskatchewan (Clemett, 2023) stated,

> Saskatchewan will need more than 8,000 new apprentices and 5,000 new journeypersons to meet labour demand requirements between now and 2026, yet the Saskatchewan Apprenticeship and Trade Certification Commission projects new apprenticeship registrations and completions will be below market demand (at about 7,000 and 4,000 respectively). This will leave a market gap of about 1,000 new apprentices and 1,000 new journeypersons (p. 4).

Since December 2022, the Saskatchewan Distance Learning Centre (Sask DLC) has provided an online opportunity for kindergarten to Grade 12 students to complete elementary and secondary education. Trades classes are also included in the course offerings. The Sask DLC accommodates the hands-on element of the 2020 Saskatchewan Curriculum Guide by incorporating a work placement program at the grade 11 and 12 levels. The remainder of Canadian provincial and territorial online learning centres do not provide *any* trade training online. The lack of online tech/voc training directly relates to the need for hands-on experience and training. Post-secondary institutions do not have an option for online trade training.

Many learners are turning to online resources found through sites such as Google and YouTube for micro-learning. Micro-learning has been present since the 1960s; however, with today's technology, it has become much more popular (Díaz Redondo et al., 2020, p. 3124). Micro-learning takes the information to be disseminated and breaks it into

short videos, animations, or sound bites. The content is shortened and simplified for quick absorption, often interspersed with small activities or labs. Micro-learning can work well with hands-on tech/voc classes. However, the activities or labs must still be supervised and conducted in person and, therefore, do not meet distance learning requirements. Furthermore, Samala et al. (2023) stated, “Microlearning [is] only occasionally suitable for mastering complex skills that require more than a week of continuous content or for pursuing long-term performance objectives” (p. 20).

Augmented reality (AR) and virtual reality (VR) can help close the gap in online learning and training brought about by the pandemic. Several automotive manufacturers have already turned to VR and AR to educate employees rather than create the need for long-distance travel. Leading European companies such as Volkswagen, Audi, BMW, and Peugeot utilize VR and AR as cost-saving measures to ensure uniform training throughout the company and its divisions. While the companies, as mentioned earlier, provide specialized training to adults with a foundational understanding of automotive technology, they provide an example of the efficient use of technology to bridge distances. When educators present concepts and learning objectives to students, imagery often becomes extremely important. For specific outcomes, the imagery presented is sufficient for the learner to grasp and understand the meaning and importance. However, “it is easier to understand how a machine works by visualizing the process of its operation than by reading a textual explanation. And, when the visualization is in 3D / VR, it is even clearer” (Elmqadden, 2019, p. 237).

Stone et al. (2011) conducted a study that compared the results of welders trained in the traditional method with a group trained using virtual reality. They found that the “overall performance for three of the four weld types . . . was not distinguishable between the training groups” (p. 567). However, they also found that students within the VR group required less training time and “acquired task-critical skills faster than their TW group [traditional training] counterparts, thus reducing the time investment needed to achieve competency levels necessary for testing” (p. 567). Furthermore, using consumable products (welding rods, metal, etc.) was not required, reducing operational costs (Stone et al., 2011, p. 569).

Paszkiewicz et al. (2021) point out several advantages and disadvantages (see Appendix A, Table 1). However, while the “lack of real consequences for mistakes and errors” (Paszkiewicz et al., 2021, p. 8) can offer unforgettable life lessons, it is incredibly beneficial when dealing with high school students. The errors will not disable machinery or cause injuries. Students successfully completing VR tasks will create more confidence and proficiency, and repetition will allow mastery. Another disadvantage of a virtual environment is that the weight and size of manipulated objects in VR are not comparable to real life. In other words, the tightness of a seized bolt or nut cannot be simulated effectively – all scenarios will have an eventual positive outcome.

AR is less frequently used because of the developmental and maintenance costs (Lee, 2012, p. 14). However, Lee (2012) stated,

> BMW technicians, wearing special data goggles and connecting to their computer servers, have all the information at their disposal, precisely where they need it: in the workplace, at the vehicle. By wearing AR glasses, for example, mechanics receive additional three-dimensional information of the part they are repairing to help them in diagnosing and solving the fault (p. 18).

Therefore, AR would not be as feasible in a high school setting as it provides a visual overlay of instruction to already trained technicians. However, as the technology is enhanced and the costs decrease as demand increases, augmented reality will engage the technical, industrial, and safety training grounds much more effectively than VR. Huang et al. (2019) found that while VR users will experience a more significant spatial presence in the simulation, AR users retained greater amounts of information. In other words, different types of cognition were activated; VR participants were more likely to focus on the visual space rather than the information presented, and AR participants could focus more on the information presented instead of the environment.

As technology improves and the demand for online learning increases, teachers must become more familiar with online instruction and design. The Wyoming Department of Education collaborated with the Wyoming Virtual Academy and college administrators "to develop training for teachers to learn effective online course development and delivery techniques" (Shepherd et al., 2016, p. 42). A Google search for "classes on how to teach online" produces thirty-one pages of options ranging from YouTube tips and tricks for effective online classes to short certificate courses from accredited and non-accredited sources. Even the websites or courses offered by reputable universities such as Queen's University, McMaster University, and the University of Waterloo are not required by pre-service or graduate student teachers. As Shepherd et al. (2016) point out, "With trends in online learning and demands for distance education increasing, teacher education programs are well advised to create and/or revise programs that address this need" (p. 46).

Future Research Recommendations

Very few studies have examined the use of VR or AR in tech/voc classes at any level, but especially at the high school level. The studies conducted have involved industry, post-secondary training, medicine, and science/engineering. The number of papers published on the use of VR fell from 38 in 2019 to 7 in 2021, see Figure 1 (Hernández-Chávez et al., 2021, p. 3). Prior to 2019, the number of publications was still unreasonably low. Furthermore, the average participants in previous studies were university students or older adults.

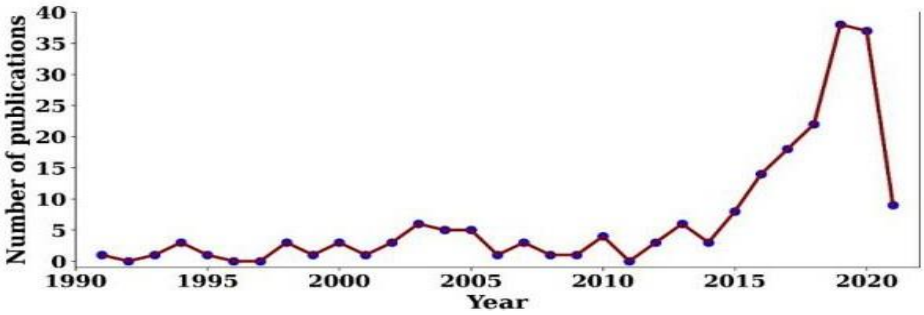

Figure 1: Distribution of published documents over time on the use of Virtual Reality in education and training in automotive industry (Hernández-Chávez et al., 2021, p. 3).

Going forward, more studies need to be conducted on AR and VR in secondary-level schools. However, particular attention must be paid to the benefits of utilizing the technologies in high school classroom settings, focusing on tech/voc classes.

Additionally, budgetary constraints in school and school divisions amid today's economic climate make it difficult to purchase the equipment and programming necessary for VR and AR facilities. A feasibility study should be conducted to investigate rental equipment and programming systems. Historically, businesses such as BlockBuster provided rentals of video games and movies and rented equipment such as video players and gaming consoles. As VR and AR equipment will likely not be available in a full-time classroom, the justification for purchasing the expensive apparatus may be difficult for educators.

Key Takeaways

Insufficient Replacement Rate:

- The current rate of replacing retiring tradespeople is inadequate, necessitating immediate action to address the skills gap.

The Role of High School Tech/Voc Courses:

- High school technical and vocational courses are crucial in sparking interest among youth in skilled trades, which could help bridge the impending skills gap.
- These courses provide essential skills for manufacturing, repair, and service industries.

The Potential of AR and VR in Education:

- AR and VR can enhance online learning by providing immersive and practical training experiences.

- Studies show VR training can be as effective as traditional methods and can reduce training time and costs.
- AR, though less frequently used due to higher costs, offers valuable on-the-job support and training.

Challenges and Benefits of VR and AR:

- VR reduces the risk of real-world consequences from mistakes, making it particularly useful for high school students.
- Successful VR training can boost student confidence and proficiency.
- AR provides real-time information and support.
- High initial costs for VR/AR hardware and software make it less appealing based on budgeting constraints.

Conclusion

Skilled tradespeople are in high demand in Canada. The inability to provide practical training over long distances substantially impacts the number of apprentices and technical college graduates. Distance education has become essential and desired to teaching and learning in schools today. Since the pandemic, more students have turned to online classes, and tech/voc classes must keep pace. In an almost daily technological advancements era, systems that advocate for hands-on learning must be explored and developed. Most online technical/vocational training options cannot simulate the skill development needed to succeed in a skilled trade. VR and AR implementation in tech/voc classes are the most beneficial programs for incorporating hands-on learning. VR and AR have been successfully implemented in large corporations for distance training of practical skills necessary for diagnosis, service, repair, and manufacturing. High schools are the breeding ground for sparking interest in the trades as viable career paths. If secondary education cannot accommodate this new era of technological students, the future of skilled tradespeople and our economy are at risk.

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Conflict of Interest

The author does not declare any conflict of interest.

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Appendix A

Advantages	Disadvantages
It enables creating complex test scenarios, experiments and experiments that are difficult to implement in a real-world setting.	Costs are associated with creating an appropriate educational station using VR technology based on professional hardware and software.
Enables one to gain confidence in implementing technical procedures and activities	Requires a lot of work to create a virtual environment with many test scenarios and details
Allows for multiple repetition of experiences, experiments, or situations.	Limited scope or lack of ready-made teaching scenarios.
Saves money and time associated with setting up actual test stations.	No real consequences for mistakes and errors made.
Ensures scalability of educational activities.	Limits interpersonal contacts and experiences.
Reduces consumption of real resources.	High probability of acquiring routine in the actions taken.
Has the ability to adapt and apply to various fields and areas of education.	The possibility of ignoring basic laws of physics.
Increases the ability to communicate and collaborate with people in remote locations.	It reproduces better or worse the given reality but is not able to replace it entirely.

Table 1: Advantages and disadvantages of using VR technology in education (Paszkiewicz et al., 2021, p. 8).