FSC Evaluation Report - NORCAT

Leveraging Technology to Develop Modern Mining Skills

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Key Findings

- The blended learning training programs in this project provided opportunities and career pathways in the skilled labour industries for our target populations – 66% of learners were Youth (aged 29 and under), 33% identified as Indigenous, and 14% identified as Women.
- 41 students have gained employment in the skilled trades immediately after completing the hard rock miner common core training.
- Knowledge of mining practices, mining safety, and load-haul-dump (LHD) operation improved from 27% (pre-test scores) to 72% after the 5-week blended learning hard rock miner common core training.
- Self-reported confidence in operators' ability to safely start-up, inspect, and use an LHD increased from a pre-training rating of 2.3 (5-point scale) to 4.6 by the end of the program.
- The use of an Augmented reality (AR) fire extinguisher training module (FiAR) improved user confidence from an average rating of 3.4 to 4.7.
- Confidence in performing pre-operational inspections on an LHD improved from a baseline rating of 2.5 to 3.8 after the use of a virtual reality (VR) pre-op check training module.
- The use of VR also improved knowledge in what to look for during inspections and how to properly conduct an effective pre-op check from a baseline test score of 41% to a score of 96%.
- All learners agreed or strongly agreed that the AR fire extinguisher is a useful, effective training tool that will prepare them in the event of a fire.
- 97% of learners agreed that the VR training helped to reinforce the steps of a preoperational check and 100% would recommend the VR training to a colleague or friend.
- 100% of learners reported they enjoyed the learning experience using AR and 100% also reported they would recommend the AR training to a colleague or friend.
- 100% of learners agreed or strongly agreed that the new confined space simulator was an effective, useful training tool that will prepare them for their work.

Background and Introduction

Canadian labour market studies project the need for more than 130,000 new mine workers and 300,000 new construction workers with the right skills, competencies, and confidence by 2029. This project provides opportunities for career pathways for our target populations which include youth, residents of rural communities, individuals who identify as women, and individuals who identify as indigenous. Engaging these target populations not only addresses a market need, but also provides a pathway to a meaningful career and sustainable economic security. With advancements in technology, particularly

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FSC is a forward-thinking centre for research and collaboration dedicated to preparing Canadians for employment success. We believe Canadians should feel confident about the skills they have to succeed in a changing workforce. As a pan-Canadian community, we are collaborating to rigorously identify, test, measure, and share innovative approaches to assessing and developing the skills Canadians need to thrive in the days and years ahead. The Future Skills Centre was founded by a consortium whose members are Toronto Metropolitan University, Blueprint ADE, and The Conference Board of Canada

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with respect to virtual reality and augmented reality, it is important to evaluate its effectiveness as a learning tool and if it should be used in training programs. We have generated evidence, learned, and now seek to quantify and learn more about the true value of integrating multiple learning technologies (VR, simulation, and now AR) into broader blended learning experiential training programs. New workforce entrants are seeking this type of learning and development experience while employers are concurrently seeking cost-effective and innovative methods to train their workforce to be both productive and safe on the job.

The construction industry in Ontario is not known for leveraging learning technologies and tends to lean on traditional means of training. This project enabled the build of an in-demand, new, scalable one-week confined space blended learning training program that integrates classroom education, AR learning technology, and a customized confined space container simulator to introduce learning technology to the construction industry in Ontario. This program includes confined space entry/awareness, confined space attendant training, and confined space rescue training. A new and improved version of an augmented reality fire extinguisher training tool was also developed as part of this project and launched in the confined space rescue training as well as the hard rock miner common core program.

Building on the first FSC-funded program, we continued to use the hard rock miner common core training program to test the effectiveness of AR, VR, and Simulator training together in a blended learning program.

Evaluation Methods

During the five-week blended-learning Hard Rock Miner Common Core Training Program, trainees participated in the following training activities:

- E-Learning Theory Modules
- Equipment Simulator Training (LHD)
- Virtual Reality Pre-Op Check Training (LHD)
- Hands-On Practical Training Underground Training

In order to determine if we were successfully developing the skills of our students using the blended learning training programs, we looked to test confidence, knowledge gained, and operational performance on an underground loader (LHD). To do this, we used knowledge assessments and confidence surveys to understand their knowledge gained and self-reported confidence in mining practices, the use of an LHD, and fire-fighting procedures at three points in time: baseline (pre-training), after week 1 (learning technology), and post-training (practical skills training). Hands-on skills were evaluated by trainers via a performance checklist that gave the students scores on the following metrics: driving procedures, dumping procedures, mucking procedures, and safety performance. This data was used to compare against other data including operator performance in the LHD simulator. VR effectiveness was determined by assessing knowledge and confidence between scores at baseline and after week 1.

We also wanted to determine the level of satisfaction and collect any feedback from the students in both the hard rock miner program as well as the Confined Space training programs on their attitude and perceptions toward the learning technologies via feedback forms.

Lastly, we wanted to verify if students were gaining employment in the skilled labour industries upon graduating the hard rock miner program. Sociodemographic surveys were administered to determine how many people within our target populations we were reaching, and immediate outcome surveys & employment status surveys were administered post-training to determine if they were securing new jobs in mining or related sectors.

Results and Discussion

Over the course of this project, 174 students participated in hard rock miner training and 145 completed confined space entry, attendant, and rescue training. We were successful in recruiting students from our target demographic as 33% of our hard rock students identified as Indigenous, and 66% were youth (Figure 1).

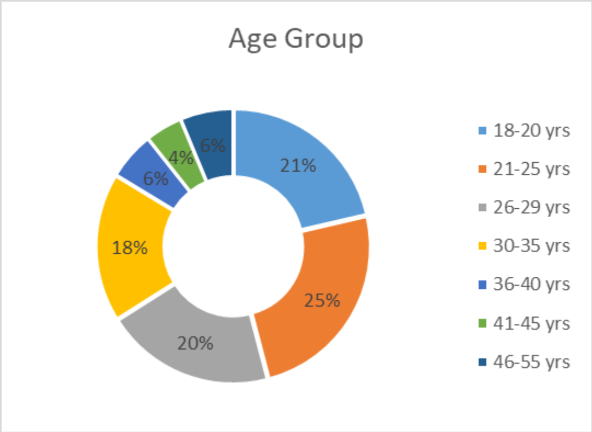

Figure 1: Age distribution for hard rock miner common core participants

Throughout the course of the 5-week program, knowledge improved dramatically from an average baseline test score of 27% to an average score of 72% post-training. Overall self-perceived confidence improved from an average rating of 2.3 (5-point scale) to a post-training rating of 4.6 (Figure 2). The VR pre-op check training tool improved knowledge around pre-operational inspections from an average baseline test score of 41% to 96% post-training. Confidence also improved from an average rating of 2.5 to 3.8 after taking the VR training.

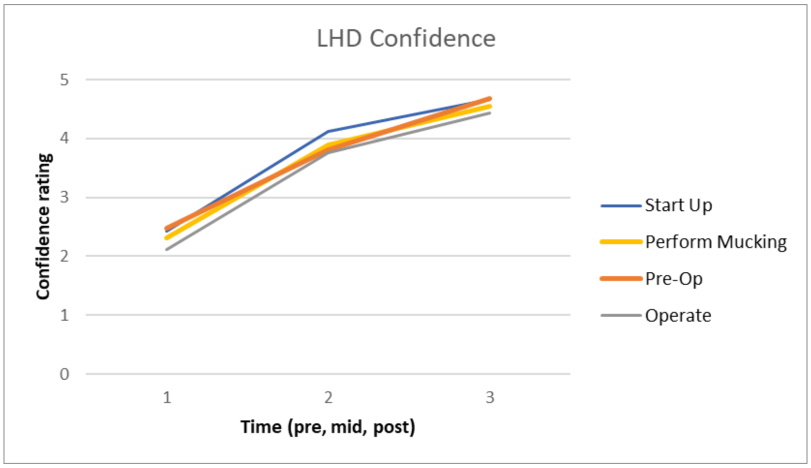

Figure 2: Average self-reported confidence ratings from hard rock miner common core participants

The use of augmented reality through the FiAR training tool also improved confidence of using a fire extinguisher from a rating of 3.4 to 4.7. The FiAR also improved student knowledge and confidence in identifying the classification of fires (average rating of 3.4 to 4.2) and how to select the appropriate extinguisher type for the class of fire (3.3 to 4.2).

It was very encouraging to see that the VR program is intuitive enough that people of all ages and experience levels were able to enjoy the learning experience similarly. The feedback forms showed an average rating of nearly 5 (strongly agree) for the statement: "The VR exercise was easy to use".

The following anecdotal evidence from the learners who took the VR and Simulator training speaks to the learning technologies' effectiveness:

- "I have enjoyed learning from instructors and feel confident in my training with the learning tools provided."
- "Prepared us very well for real life situations"
- "I was expecting to be very nervous going to the mine Monday, but I am pretty confident and excited instead"
- "I found the training very interesting, trainers were very knowledgeable and well prepared to teach us. I enjoyed using the simulator as I found it useful to practice on it before going underground"
- "It was amazing learned a lot and feel prepared for underground training"
- "… The simulator also impressed me quite a bit and I feel confident in running the machine."

In addition, 100% of students report they would recommend the AR training to a colleague. All students also agreed or strongly agreed that the AR fire extinguisher is a useful training tool that will prepare them in the event of a fire. All students agreed that the confined space simulator will prepare them for their work. 100% also reported they enjoyed using the AR training.

Furthermore, the confined space simulator was a great success. This simulator is one of a kind in the construction industry and we have received wonderful feedback from all students. Due to the novelty of the simulator and the competitiveness of the market for training construction workers in the GTA, we had a target of 50-60 students for the first year. We blew past that number, nearly reaching 150 students. Marketing the new confined space simulator went very well and the experience did not disappoint the students as they recommended the training to their colleagues. 100% of students in the three confined space programs reported they would recommend the training to a friend or colleague. Additionally, all learners agreed that the newly built confined space simulator is a useful training tool that better prepared them for their work. Lastly, all learners agreed that the learning technology, props and features within the simulator were effective and useful learning tools.

Another achievement was that 41 students have gained employment in the skilled trades after completing the hard rock miner common core training. Low response rates are observed in the 3-month follow-ups but we do suspect more graduates have gained employment in the mining industry than reported. 78% of trainees also reported in the Immediate Outcomes survey that they think they will be able to advance in their current career after taking this training.

Lastly, we were unable to determine any correlations between performance in the LHD simulator and performance in the field (hands-on LHD training). We looked at three simulator performance indicators based on data availability: incorrect dumping procedures, lifted/spun wheels while mucking, and bucket/frame of machine struck the rock face. Based on how many errors they made for each indicator, we were able to group the best performers in the sim and the poorest performers in the sim. When analyzing these individuals' performances in the field on the actual machine, we found no strong correlation at all. We suspect that the evaluation checklist relies too much on trainer subjectivity and perhaps was not a reliable indicator of hands-on skills performance. Further research is required and ongoing to determine this effect that simulator training has on in-the-field LHD performance.

Conclusion

Our findings suggest that the blended learning model is effective for gaining knowledge and confidence in performing skills. This training method also improves learner engagement as we have seen tremendous student satisfaction. The use of AR, VR, and simulator training may be a more interesting, engaging, and effective way to train skilled operators vs. traditional training methods. Employers in the skilled labour industries may want to adopt learning technology for their training department to aid in worker recruitment, improve learning experiences, and increase operator confidence. Ultimately, these training programs will provide the relevant skills and build confidence for skilled labour workers to fill in-demand, sustainable, and well-paying jobs in important Canadian industries.