

An Analysis of the Relationship Between WHMIS Certification and Holders' Knowledge After Being Certified

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Abstract

Background: Workplace Hazardous Materials Information System (WHMIS) is the Canadian standard for hazard communication. This system consists of hazard classification, cautionary labelling of containers, safety data sheets, as well as worker education and training programs. In British Columbia, WorkSafeBC is the legal authority for occupational health and safety. Employers must provide worker education and training while workers must participate in these learning opportunities as required. Despite these requirements, there is currently no legislation that mandates WHMIS certificate holders to recertify after a period of time. Holders may work decades for the same organization and receive their one and only training session in their careers when they started working. There is a likelihood that information vital to occupational health and safety is gradually forgotten. This research study examined WHMIS knowledge retention of holders upon being certified.

Methods: Self-administered online surveys were created on SurveyMonkey then distributed via social media platforms and educational groups. The survey consisted of 17 questions relating to demographics and WHMIS knowledge. The data was analyzed on Number Cruncher Statistical System (NCSS) 2021 using independent t-test and analysis of variance (ANOVA) statistical tests.

Results: The average WHMIS knowledge score was 60%. Statistical analyses showed no statistically significant differences in WHMIS certificate holders' knowledge (i) after every four years upon being certified ($p = 0.14$ and $p = 0.07$), (ii) based on the number of times that holders successfully completed the certificate ($p = 0.68$ and $p = 0.53$), (iii) as well as no difference in holders' knowledge and holders' age ($p = 0.20$ and $p = 0.07$) or gender ($p = 0.65$ and $p = 0.72$). However, there was a difference in holders' self-perceived knowledge and holders' actual knowledge ($p = 0.02$ and $p = 0.03$).

Conclusions: This research study found a difference in WHMIS certificate holder's self-perceived knowledge and the holder's actual knowledge; those perceiving better WHMIS

knowledge scored significantly higher than those who perceived weak WHMIS knowledge. As such, organizations should offer WHMIS refresher courses to holders who may find it beneficial to review materials on an annual basis.

Keywords: certificate, certification, knowledge retention, occupational health and safety, WHMIS

Introduction

The WHMIS program was established to ensure that information about hazardous products is effectively communicated to workers (Canadian Centre for Occupational Health and Safety, 2020). Workers' responsibilities are to understand the WHMIS program, recognize products' hazards, perform related safe work procedures, and know how to respond in an emergency (Canadian Centre for Occupational Health and Safety, 2020). There are two editions of WHMIS: 1988 and 2015 (University of Toronto, 2020). The new edition was updated to align with United Nations' Globally Harmonized System of Classification and Labelling of Chemicals due to increased global trading of hazardous materials. Hazard classification and communication requirements is now coordinated with the United States and other major trading partners (WorkSafeBC, 2020). There is a multi-year transition period where both editions may be accepted (WHMIS, 2020). Key changes include new supplier label requirements, new hazard classes, more

comprehensive hazard classification criteria, physical hazard criteria aligning with Transport of Dangerous Goods Regulations, standardized language of hazard and precautionary statements, as well as safety data sheets (University of Toronto, 2020).

The establishment of legislation surrounding hazardous materials as well as occupational health and safety at federal and provincial levels confirm the significance of the issue. Even though there is no legislation at any governmental levels regarding WHMIS certification and renewal requirements, the development of this legislation will be supplementary to the existing ones. When workers are familiar with information regarding hazardous materials they contact, this may potentially lead to fewer work-related deaths and injuries. The monetary costs associated with work-related deaths and injuries are immense. Not to mention, work-related deaths and injuries lead to a decrease in productivity which is a disadvantage for an organization's profit. Investment into regular WHMIS education and training is a possible prevention

mechanism for occupational health and safety matters.

Presently, there are no research studies that have examined knowledge retained by WHMIS certificate holders post certification. The literature emphasizes the significance of WHMIS education and training programs provided by employers to employees, but no frequency of education and training is mentioned. Some employers provide frequent education and training opportunities while some do the bare minimum to satisfy legal requirements. As there is a cost associated to education and training, some employers are not interested in devoting their time and effort into the WHMIS program. With no standardized education and training frequency, employees who work with similar hazardous materials in different organizations may have concerning differences in knowledge. As such, the purpose of this study was to investigate the relationship between WHMIS certification and knowledge retention post certification.

Literature Review

WHMIS Certification

The WHMIS program has six main elements: purchasing and inventory, hazard identification, inspections, worker education and training, review and evaluation, as well as document and record keeping. Employers

develop the WHMIS training for their organization while consulting a health and safety professional. As every organization is different, the WHMIS training will vary depending on what hazardous materials are present and other factors. WHMIS 2015 is categorized into two major hazard groups: physical and health (Canadian Centre for Occupational Health and Safety, 2020). Each hazard group has a list of hazard classes which is further organized into hazard categories (Canadian Centre for Occupational Health and Safety, 2020).

Employees must comprehend supplier and workplace labels. Supplier labels consist of a product identifier, pictograms, signal word, hazard statements, precautionary statements, and supplier information (Canadian Journal of Medical Laboratory Science, 2015). The signal word warns potential hazards and their severity while precautionary statements identify methods to reduce exposure (Canadian Journal of Medical Laboratory Science, 2015). Workplace labels are compulsory if hazardous material is produced, used, or transferred into another container as well as if a supplier label is replaced (University of British Columbia, 2020). A workplace label must at least include a product identifier, safe handling information, and reference to safety

data sheet (University of British Columbia, 2020).

WHMIS education and training programs do not necessarily have to be in-person. Some employers provide in-house training and education while some hire organizations to perform the task. Topics discussed include interpretation of supplier and workplace labels as well as SDS; procedures for safe use, handling, and disposal of a hazardous material; as well as emergency procedures involving a hazardous material (Workers' Compensation Board of British Columbia, 2019). Workers who successfully complete the WHMIS certificate must be able to answer four questions: What are the hazards of the product?, How do I protect myself from those hazards?, What do I do in case of an emergency?, as well as Where can I get more information? (Workers' Compensation Board of British Columbia, 2019).

Legislation

There is currently no legislation directly related to WHMIS certification and renewal requirements. Workers who received training and education for WHMIS 1988 are not required to be certified for WHMIS 2015. In contrast, there are several legislations related to hazardous materials, workers

compensation, as well as occupational health and safety.

The federal legislation regarding hazardous materials are the Hazardous Products Act and Regulation. The Hazardous Products Act states that suppliers of hazardous materials must communicate associated hazards via product labels and SDSs as a condition of sale and importation for workplace use (Government of Canada, 2020). The Hazardous Products Regulation states the criteria for classifying hazards of chemical products as well as requirements for product labels and SDSs (Government of Canada, 2020).

In British Columbia, employers must comply with the Workers Compensation Act and Occupational Health and Safety Regulation (Government of British Columbia, 2020). As WorkSafeBC has the legal authority to enforce, stop work orders and administrative penalties may be issued (Government of British Columbia, 2020). Occupational Health and Safety Regulation is a supplementary law developed by WorkSafeBC and industry stakeholders. The goal is to prevent workplace accidents and injuries by maintaining safety standards (Government of British Columbia, 2020). The Occupational Health and Safety Regulation has three sets of requirements:

core requirements; general hazard requirements; as well as industry and activity related requirements (Government of British Columbia, 2020). Parts five to 19 discusses general hazards found in workplaces, predominantly higher-hazard operations. These hazards include safe use of chemicals, confined space entry procedures, guarding of machinery, and use of mobile equipment (WorkSafeBC, 2020).

Occupational Health and Safety

Some work-related deaths and injuries are due to workers' poor understanding of hazardous materials that they handle. In 2019, there were 1,453 work-related death claims while the manufacturing sector had 289 (WorkSafeBC, 2020). Out of the nine sectors, manufacturing had the second highest number of work-related deaths with the highest being 354 in construction (WorkSafeBC, 2020). Subsectors included in manufacturing are food and beverage products; metal and non-metallic mineral products; petroleum, coal, rubber, plastic, and chemical products; wood and paper products; as well as other products. This sector works with hazardous materials at a high frequency compared to other sectors.

Work-related death benefits including health care and rehabilitation costs totaled \$3,715,414 for British Columbia in 2019

(WorkSafeBC, 2020). Out of the nine sectors, manufacturing had the fourth highest work-related death benefits including health care and rehabilitation costs (WorkSafeBC, 2020). The monetary costs for health care-only, short-term disability, and long-term disability claims in British Columbia for the manufacturing sector are much more significant than work-related death benefits.

In 2019, costs for health care-only claims totaled \$10,560,083; short-term disability including health care and rehabilitation costs totaled \$54,883,084; as well as long-term disability including health care and rehabilitation costs totaled \$70,784,581 (WorkSafeBC, 2020). Out of the nine sectors, manufacturing had the second highest costs for health care-only claims as well as fourth highest costs for short- and long-term disability claims including health care and rehabilitation costs (WorkSafeBC, 2020).

In 2019, the overall total for manufacturing claim costs in British Columbia including costs for health care-only claims, costs for short- and long-term disability claims including health care and rehabilitation costs, as well as work-related death benefits including health care and rehabilitation costs were \$139,943,161 (WorkSafeBC, 2020). Out of the nine sectors,

manufacturing had the fourth highest overall total claim costs (WorkSafeBC, 2020).

Materials and Methods

Materials

This research study used SurveyMonkey to create self-administered online surveys and collect data, Microsoft Excel to store data, NCSS 2021 to analyze data, Reddit to distribute surveys, as well as a laptop with internet access to perform aforementioned and related activities.

Methods

Surveys were created on SurveyMonkey then distributed via social media platforms such as Reddit's r/takemysurvey as well as educational groups such as British Columbia Institute of Technology's occupational health and safety program. The survey was opened on January 30, 2021 and closed on February 14, 2021 for a total of 16 days. This data collection method was designed to be completed by participants without the intervention of investigators (Lavrakas, 2008). The survey consisted of 17 questions where the first question was related to participants' eligibility to participate, the next five questions were related to participants' demographics, the next 10 questions were related to participants' knowledge of WHMIS, and the last question was related to collecting participants' emails

to win a \$100 gift card should they wish to enter the draw. As the purpose was to explore the amount of knowledge retained by WHMIS certificate holders after being certified, questions related to WHMIS knowledge have one correct answer for each question. Participants received a mark of one for each correct answer and zero for each incorrect answer—no half marks were awarded. If participants did not wish to answer a question, they had the option to skip that question. These 10 questions and answers were based on the WHMIS 2015 Information for Employers published by SAFE Work Manitoba which educates workers regarding hazardous products that are sold in or imported into Canada as well as those meant to be used, handled, or stored in Canadian workplaces (SAFE Work Manitoba, 2016). The maximum possible mark to receive for questions related to WHMIS knowledge was 10 marks which was converted to a percentage for statistical analysis. As participants had the option to skip questions, there were two methods used to calculate the percentage for statistical analysis. The first method was calculated by dividing the number of correct answers by 10. This method gave a mark of zero for skipped questions. The second method was calculated by dividing the number of correct answers by

the number of non-skipped questions. This method took skipped questions into consideration as the denominator is reduced based on how many questions were skipped.

Inclusion and Exclusion Criteria

Any individuals residing in Canada who successfully completed the WHMIS certificate (i.e., 1988 or 2015 edition) were eligible to participate in the self-administered online survey. The exclusion criteria included any individuals who do not meet the inclusion criteria as well as friends, family, and classmates of the lead author.

Ethical Considerations

This research study received British Columbia Institute of Technology Research Ethics Board approval.

Results

Description of the Type of Data Collected

The survey had 17 questions and three types of data were collected: nominal, ordinal, and discrete numerical. There were three questions with nominal data, two questions with ordinal data, and 12 questions with discrete data. Nominal data were collected in question one regarding participants' eligibility to participate (i.e., yes or no), question three regarding participants' gender (i.e., female, male, and other), and question 17 regarding the collection of participants' emails to enter to win a \$100 gift card.

Ordinal data were collected in question two regarding participants' age groups (i.e., ≤ 19 , 20 to 29, 30 to 39, 40 to 49, 50 to 59, 60 to 64, and ≥ 65) and question six regarding participants self-perceived WHMIS knowledge. Discrete data were collected in question four regarding the number of times that participants successfully completed the WHMIS certificate (i.e., 1, 2, or ≥ 3), question five regarding when participants completed their most recent WHMIS certificate (i.e., year ranging from 1988 to 2021), as well as questions seven to 16 regarding participants' knowledge of WHMIS (i.e., mark of one for each correct answer and zero for each incorrect answer). The average WHMIS test score was 59% when all ten questions were included and 61% when skipped questions were excluded.

Descriptive Statistics

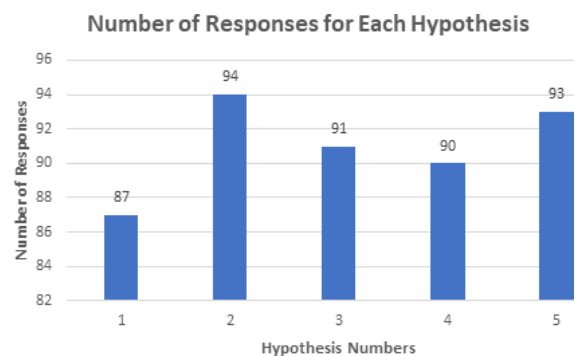


Figure 1: Number of Responses for Each Hypothesis

In Figure 1, only some responses were usable for data analysis out of the 168 responses that were collected. The usable responses varied between each hypothesis as

participants who skipped questions selected different questions to skip.

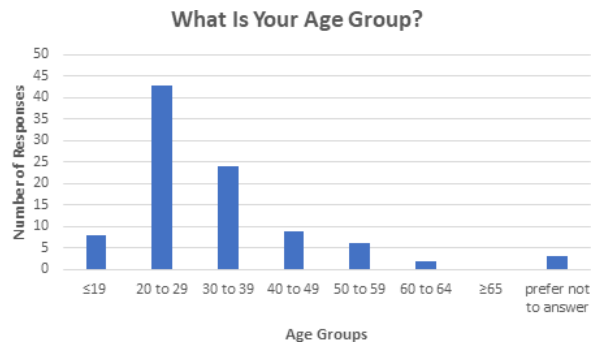


Figure 2: Number of Responses for Each Age Group

In Figure 2, 95 participants answered the question pertaining to age group. Most respondents were 20 to 39 years of age.

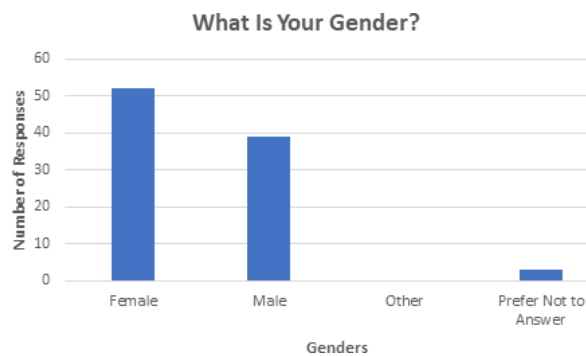


Figure 3: Number of Responses for Each Gender

In Figure 3, 94 participants answered the question pertaining to gender. Approximately 20% more females responded to the survey compared to males.



Figure 4: Number of Responses for the Number of Times that the WHMIS Certificate Was Successfully Completed

In Figure 4, 95 participants answered the question pertaining to the number of times they have successfully completed the WHMIS certificate. More respondents indicated that they completed the WHMIS certificate three or more times than once or twice previously.



Figure 5: Number of Responses for the Year the Most Recent WHMIS Certificate Was Completed In

In Figure 5, 95 participants answered the question pertaining to the most recent year they completed the WHMIS certificate. Most respondents completed their WHMIS certificate in the past two years.

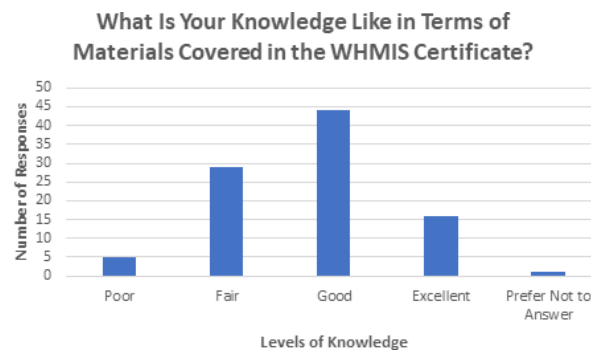


Figure 6: Number of Responses for Each Level of Knowledge

In Figure 6, 95 participants answered the question pertaining to their self-perceived knowledge in terms of materials covered in

the WHMIS certificate. Most respondents perceived their knowledge to be good.

Inferential Statistics

There are two p-values for each set of hypotheses as there are two methods to calculate the percentage received for WHMIS knowledge questions due to participants having the option to skip questions. The first method was calculated by

dividing the number of correct answers by 10. This method gave a mark of zero for skipped questions. The second method was calculated by dividing the number of correct answers by the number of non-skipped questions. This method took skipped questions into consideration as the denominator is reduced based on how many questions the participant skipped.

Table 1: Summary of Inferential Statistics

H₀ and H_A	Test Used	Result	Conclusion
H ₀ : There is no difference in WHMIS certificate holder's knowledge after every four years upon being certified. H _A : There is a difference in WHMIS certificate holder's knowledge after every four years upon being certified.	ANOVA	1) P-Value: 0.144 1) Power: 38.1% 2) P-Value: 0.071 2) Power: 53.8%	Fail to reject H ₀ and conclude that there is no difference in WHMIS certificate holder's knowledge after every four years upon being certified. As there is a potential beta error, increasing the sample size may reduce the error. The low power is 38.1% and 53.8% suggesting that there is truly no difference.
H ₀ : There is no difference in WHMIS certificate holder's knowledge and the number of times that holders successfully completed the certificate. H _A : There is a difference in WHMIS certificate holders' knowledge and the number of times that holders successfully completed the certificate.	ANOVA	1) P-Value: 0.684 1) Power: 10.3% 2) P-Value: 0.532 2) Power: 12.7%	Fail to reject H ₀ and conclude that there is no difference in WHMIS certificate holder's knowledge and the number of times that holders successfully completed the certificate. The low power is 10.3% and 12.7% suggesting that there is truly no difference.
H ₀ : There is no difference in WHMIS certificate holder's knowledge and the holder's age group. H _A : There is a difference in WHMIS certificate holder's knowledge and the holder's age group.	ANOVA	1) P-Value: 0.202 1) Power: 54.8% 2) P-Value: 0.068 2) Power: 71.8%	Fail to reject H ₀ and conclude that there is no difference in WHMIS certificate holder's knowledge and the holder's age group. As there is a potential beta error, increasing the sample size may reduce the error. The power is 54.8% and 71.8% suggesting that there may truly be no difference.
H ₀ : There is no difference in WHMIS certificate holder's knowledge and the holder's gender. H _A : There is a difference in WHMIS certificate holder's knowledge and the holder's gender.	Independent Samples T-test	1) P-Value: 0.650 1) Power: 7.4% 2) P-Value: 0.717 2) Power: 6.5%	Fail to reject H ₀ and conclude that there is no difference in WHMIS certificate holder's knowledge and the holder's gender. The low power is 7.4% and 6.5% suggesting that there is truly no difference.
H ₀ : There is no difference in WHMIS certificate holder's self-perceived knowledge and the holder's actual knowledge. H _A : There is a difference in WHMIS certificate holder's self-perceived knowledge and the holder's actual knowledge.	ANOVA	1) P-Value: 0.019 1) Power: 76.2% 2) P-Value: 0.030 2) Power: 69.9%	Reject H ₀ and conclude that there is a difference in WHMIS certificate holder's self-perceived knowledge and the holder's actual knowledge. As there is a potential alpha error, decreasing the p-level cut-off from 0.05 to 0.01 may reduce the error. The power is 76.2% and 69.9% suggesting that there may be a true difference.

Discussion

This research identified an average WHMIS knowledge score of approximately 60% among participants and explored five sets of hypotheses related to WHMIS certification. Results showed there was no difference in WHMIS certificate holders' knowledge after every four years upon being certified, no difference in holders' knowledge and the number of times that holders successfully completed the certificate, as well as no difference in holders' knowledge and holders' age and gender. This may suggest that holders' knowledge is retained as they regularly apply their knowledge at work regardless of how long ago they were certified, how many times they have been certified, their age, or their gender. However, there is a difference in holders' self-perceived knowledge and holders' actual knowledge. This may suggest that holders who perceived themselves as having good knowledge are different with regards to scores than holders who perceived themselves as having poor knowledge. Perception of knowledge is a good predictor of actual knowledge. Holders with poor self-perceived knowledge may be at risk of incurring in accidents or mistakes.

To the best of the authors' knowledge, there are currently no research studies examining the amount of knowledge retained

by WHMIS certificate holders upon certification. This research study is the first of its kind with regards to examining WHMIS certification and knowledge retention. However, there are research studies that explored knowledge retention for food safety certifications. The *Food Handler Knowledge Retention: Retraining Effectiveness in FOODSAFE-Trained Food Handlers in British Columbia, Canada* research study found that food handlers who were retrained in FOODSAFE level one scored the highest in the knowledge-based survey, food handlers who were trained scored the second highest, and food handlers who were not trained scored the lowest (Peng, 2012). Knowledge retention increased with the amount of training involved. Another research study, *Food Safety Knowledge Retention Study*, found that certified food handlers had greater food safety knowledge than uncertified food handlers (Hislop & Shaw, 2009). The researchers recommended that food handlers need to complete food safety certifications and recertification should occur at least once a decade (Hislop & Shaw, 2009). Conclusions for both research studies supported the necessity for retraining to improve knowledge retention, but this research study claimed otherwise.

There were methodological limitations as data was collected through surveys which required access to a device that supports the internet. Even though the cover letter asked participants to answer all questions to the best of their ability without referring to any materials, participants were a click away from searching for answers.

Knowledge Translation

Even though four sets of hypotheses resulted in no statistical significance, there is a difference in WHMIS certificate holders' self-perceived knowledge and holders' actual knowledge. Holders who perceived themselves as having excellent knowledge had highest scores with the mean score as 68%. Holders who perceived themselves as having poor knowledge had lowest scores with the mean score as 41%. This finding supported that a significant difference exists between holders who perceived themselves to be more knowledgeable compared to holders who perceived themselves to be less knowledgeable. Organizations can offer refresher courses to holders who may find it beneficial to review materials on an annual basis. Refresher courses can be an accelerated version of the regular certificate course as those who participate are already certified. The goal is to minimize work

related deaths and injuries due to poor understanding of hazardous materials.

Limitations

The survey collected 168 responses in 16 days, but only 87 to 94 responses were usable for data analysis. A greater number of responses could have been collected if the survey was available for a longer period. This particular data collection method was selected due to the current health orders related to the pandemic. If this research study was conducted in a non-pandemic situation, the addition of self-administered in-person surveys would complement each other by increasing the number of responses.

Self-administered in-person surveys reach participants who do not have access to a device that support the internet which solves the issue presented in self-administered online surveys. As the investigator would be present during the completion of self-administered in-person surveys, participants' integrities would be overseen as the chances of participants searching for answers on their devices would be significantly decreased. Similarly, participants' integrities may be increased if self-administered online surveys incorporated an invigilator program where participants are asked to turn on their cameras and microphones during the process. These

programs do not allow participants to search for answers as well as flag suspicious movements and sounds where the investigator may review. Internal and external validity should be increased with an increased number of responses and decreased likelihood of searching online for answers.

Future Research

- Will an industry-specific WHMIS certification provide greater benefits to workers than a general WHMIS certification?
- Will requiring secondary school students to complete WHMIS certifications increase their confidence in handling hazardous products?

Conclusions

The purpose of this research study was to analyze the relationship between WHMIS certification and holders' knowledge after being certified. This research study identified no differences in variables such as time since certification, number of times certified, age, and gender. However, it did show a difference in WHMIS certificate holders' self-perceived knowledge and holders' actual knowledge. Those who considered themselves to have low knowledge obtained lower knowledge scores and those who perceived themselves to have

more knowledge obtained higher knowledge scores. Organizations can offer refresher courses to holders who may find it beneficial to review materials on an annual basis. Refresher courses can be an accelerated version of the regular certificate course as those who participate are already certified. The goal is to minimize work-related deaths and injuries due to poor understanding of hazardous materials.

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Competing Interest

The lead author and supervisor declare that they have no competing interests.

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