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A Relational Study of Wisconsin's Water Operator Certification Program

By Mr. Fred S. Rice

The availability and use of professional certifications are on the increase in many diverse technological areas of the workforce such as construction (Dunn, 2003; Ferrantella, 2000), engineering (Gowder, 2002), education (Csapo, 2002), information (Brookshire, 2000; Matthys, 2002), human resources (Glister, 2000; Tomlinson, 2001), and the health industry (Ukens, 2003). Many employers are considering professional certification as an integral benchmark in determining employee knowledge and skill level (Alexander, 1998; Hubble & Taylor, 2003; Sunoo, 1999) and in turn, many employees are using certification to enhance their career potential (Cohen, 2001; Karr, 2001; Kuhl, 1999).

Water Industry Certification

An occupational area that is experiencing significant employment growth is the water technology industry (Fussell, 2003). In the United States, individuals who work in the water technology industry must hold technical certification (EPA, 2002). The U.S. Environmental Protection Agency (EPA) mandates through the Federal Safe Drinking Water Act and the Federal Clean Water Act that the states are responsible for creating, funding, and maintaining a system of operator certification in accordance with the federal guidelines (EPA, 2002). In the State of Wisconsin, the governing authority that regulates water technology operator certification is the Wisconsin Department of Natural Resources (WDNR). The WDNR manages and coordinates operator certification functions through section NR114 of the Wisconsin Administrative Code (WDNR, 2000). There are six water technology certification examinations in Wisconsin: surface water (class S); groundwater (class G); distribution

(class D); iron removal (class I); zeolite softening (class Z); lime softening (class L); and volatile organic chemical removal (class V). These six written exams are administered twice a year and are open to anyone who completes the application and pays the \$25 fee per examination prior to the established deadline (WDNR, 2003).

Individuals who pass the certification exams in Wisconsin are assigned a grade level that is based on the amount of industry work experience they possess. A Grade T operator has less than one year of experience while a Grade 1 operator will have one year or more of experience. The grade level designation is important as only Grade 1 operators may serve in a management capacity at a treatment facility (WDNR, 2003).

Significance and Purpose of the Study

As certification is a requirement for industry employment and advancement, it is important for the applicants that they pass the necessary exams; for employers to have confidence in the exam system as a means of establishing operator competence level; and to maintain a qualified pool of certified employees to meet the increasing demand for operators (Fussell, 2003). The credibility of the certification process rests on the knowledge and skill level manifested by certified operators and the only industry-wide indicator presently used to determine the competence level of operators is their written certification examination score. It is important for all parties to have a better understanding of the factors that affect exam success. Information pertaining to variables that are related to successfully passing an exam could assist in improving the validity of the examinations and

enhancing the credibility of the examination results (Kubiszyn & Borich, 2000; Plume, 2001).

Although certification by examination has been required in the State of Wisconsin for more than 25 years, no research has been conducted attempting to determine the significant variables affecting successful completion by participants. WDNR certification exam administrators (P. O'Donnell, personal communication, April 2003) offer that the exams are written to favor those with experience and provide a means of certifying a participant's work-equivalency level or benchmark achievement. Many different factors may have an impact on an exam score (Hodges, 2002; Kubiszyn & Borich, 2000) and an important consideration in this certification scenario may be the knowledge level from education rather than work experience (Broad & Newstrom, 1992; Noe, 2002) that the participant brings into the exam process. The purpose of this study was to determine the relationship of work experience and education on the final grade score earned by participants on the State of Wisconsin class S water operator certification exam.

Research Question and Hypotheses

How does the score earned on the State of Wisconsin class S water operator certification examination relate to the level of work experience and the level of education of the participants?

Null Hypothesis 1. There is no main effect for level of work experience. This indicates that level of work experience does not affect the final grade score earned by an exam participant.

Alternative Hypothesis 1. There is a main effect for level of work experience. This indicates that level of work experience does affect the final grade score earned by an exam participant.

Null Hypothesis 2. There is no main effect for level of education. This indicates that level of education does not affect the final grade score earned by an exam participant.

Alternative Hypothesis 2. There is a main effect for level of education. This indicates that level of education does affect the final grade score earned by an exam participant.

Null Hypothesis 3. There is no interaction effect between the level of work experience and the level of education.

Alternative Hypothesis 3. There is an interaction effect between the level of work experience and the level of education.

Assumption and Delimitations of the Study

The most significant limitation was the limited number of sample participants. Due to time constraints and limited access to participant records, only those individuals who wrote the exam during the November 2002; May 2003; and November 2003 offerings were included. There was also a lack of previous research on the population and research parameters from which to support the current study. In addition, each of the study participants participated in a three-day training intervention prior to writing the certification exam. The potential for sampling bias or error due to the training is minimal as the entire study population and sample group participated in the same training intervention taught by the same instructor using the same curriculum. Although care has been taken to minimize the effect of these limitations, any inferences offered based on the results of this study are strictly limited in their scope and ability to be generalized to a larger population.

Statistical Methodology

To test the hypotheses, an analysis of variance (ANOVA) method was applied. Because there were two independent variables used in this study, a two-way factorial ANOVA was used and implemented in SPSS statistical software as a univariate General Linear Model (GLM). The primary reason for the use of ANOVA was that it allows for the analysis of several means at the same time while maintaining the established alpha significance level. In addition, ANOVA is a robust method of

analysis due primarily to the ability of the *F* test to withstand deviations from normality and homogeneity (Minium, Clarke, & Coladarci, 1999).

An alpha level of 0.05 was selected for this study. This will provide a 95% confidence level that the analysis will correctly reject the null hypotheses and a 95% confidence level that the variables are correctly related. In terms of risk, health and safety issues are not a factor nor are there monetary risks involved with possible erroneous results; supporting the use of a 0.05 Type I error level.

Population and Sample Description

The water operator certification exams are offered two times during the calendar year in Wisconsin and the number of participants varies considerably as the demand for the exam is based heavily on the job outlook within the water industry. The population and sample for this study included 42 individuals who participated in the State of Wisconsin class S water certification examination during the November 2002, and May and November 2003 exam offerings. As there was only one version of the exam in use, each study participant wrote the same exam. Study information was obtained from a voluntary survey of exam participants. The participants of the class S certification exam were selected as their data was most readily accessible to the researcher given the time limitations of this study.

Description of the Variables

The primary criteria used in the selection of the variables included: Are they consistent with the scope and purpose of the study, and is the data related to the variables accessible to the researcher given the limitations of this study? The dependent variable was grade score earned on the State of Wisconsin class S water certification examination. The grade score is identified as the percent answered correctly; ranging from zero to 100.

The independent variables (each with two levels) in this study included: level

of work experience, and education level. For purposes of this study, the level of work experience was coded as Grade T and Grade 1. Grade T is defined as having less than 1 year of industry work experience. Grade 1 is defined as having one year or more of work experience. These definitions of experience level are derived from how the WDNR collects the information on an exam application and subsequently uses the information to assign a certification level. An individual who passes the class S certification exam and has less than one year of work experience will be granted a Grade T certification. If an individual were to have one year or more of work experience at the time an exam is passed, he or she would be awarded a Grade 1 certification.

The level of education used in this study was coded as either Low or High. Low is defined as having less than a technical college (associate's) degree while high refers to someone with education at or beyond a technical college degree. In the area of water and wastewater operations, the highest degree offered is an associate's (technical college or two-year) degree. If an individual possesses a degree higher than an associate's degree, it will be in another academic discipline such as engineering, chemistry, or biology and it is not common, according to WDNR officials, for these individuals to work at the operational level where the technical certification is required.

Results

As displayed in Table 1, there were 22 participants who were identified as Grade 1 (one year or more experience) in terms of the independent variable work experience and 20 who were identified as Grade T (less than one year experience). Also in Table 1, it is shown that the other independent variable of education level had 22 participants identified as High (technical college degree or more) and 20 participants who were identified as Low (less than a technical college degree). It is relevant to note in Table 1 that the variables are relatively balanced in number. This is important because if there is a lack

of homogeneity of variance, an equal number of participants in each group will limit the impact.

In terms of the dependent variable (exam score), the participant's scores ranged from 75 to 100 (Table 2). A score of 100 denotes that the participant scored 100% on the certification exam questions. The entire sample group of 42 exam participants used in this study passed the examination regardless of any of the independent variables. Table 3 provides an overview of the descriptive relationships between the dependent variable and the two levels of each of the independent variables.

Figure 1 illustrates the breakdown of the dependent variable (exam score) between the independents (work experience and education level). Exam

participants who had work experience at the Grade 1 category level scored higher on the certification exam than those with only a Grade T level of experience, regardless of education level. This result is also corroborated in Figure 2. Exam participants with higher levels of work experience (Grade 1) scored better than those with little work experience (Grade T). Because the two lines do not cross in Figure 2 and the distance between the two lines remains relatively the same for the length of the plot, there is no interaction effect between work experience and education level.

Assumption of Homogeneity of Variance. An important assumption for an analysis of variance is that the data in each cell come from populations with the same variance. Levene's Test

Table 1. Participant numbers by independent variable

Between-Subjects Factors		
		N
Work Experience	1	22
	T	20
Education Level	H	22
	L	20

Table 2. Descriptive statistics of the dependent variable

	N	Range	Minimum	Maximum	Mean
Exam Score	42	25	75	100	87.52
Valid N (listwise)	42				

Table 3. Descriptive statistics of the dependent and independent variables

Dependent Variable: Exam Score					
Work Experience	Education Level	Mean	Std. Deviation	N	
1	H	95.35	3.952	17	
	L	90.00	3.391	5	
	Total	94.14	4.400	22	
T	H	85.00	2.236	5	
	L	78.67	2.410	15	
	Total	80.25	3.640	20	
Total	H	93.00	5.707	22	
	L	81.50	5.662	20	
	Total	87.52	8.083	42	

of Equality (Table 4) tests the null hypothesis that the error variance of the dependent variable is equal across groups (Minium, Clarke, & Coladarci, 1999). According to the data presented in Table 4, the significance level for the variables in this study is 0.168. As the significance value in Table 4 is greater than the established significance level (0.05), there is no reason to doubt the assumption of homogeneity.

ANOVA Statistics

Table 5 is an analysis of variance (ANOVA) table. The important columns used in this analysis are the *F* and Significance (Sig.). The *F* statistic in ANOVA determines if the means of the groups formed by values of the main effects and interaction effects of the independent variables are different enough not to have occurred by chance. If the group means do not differ significantly then it is inferred that the independent variables did not have an effect on the dependent variable. Effects with a small significance (Sig.) value (smaller than the established alpha level of 0.05) are also important.

Critical Analysis Values. In order to determine the critical value of *F* to be used in the analysis, it is necessary to obtain the degrees of freedom (*df*) for the numerator and the denominator, the established alpha level, and then use these numbers on an *F* distribution table. According to Table 5, for the main effects hypotheses, the *df* of the numerator is one, the *df* of the denominator is 38, and the alpha level is 0.05. The critical value for analysis of main effects is $F_{crit}(1, 38) = 4.10$. Also according to Table 5, for the interaction effects hypothesis, the *df* of the numerator is one, the *df* of the denominator is 38, and the alpha level is 0.05. The critical value for analysis of the interaction effects is $F_{crit}(1, 38) = 4.10$.

Test Statistics. According to the data presented in Table 5, the observed *F* value for analysis of the independent variable Work Experience main effects is $F_{test} = 85.617$. The observed *F* value for analysis of the independent variable Education Level main effects is F_{test}

Figure 1. Exam scores by work experience and education level

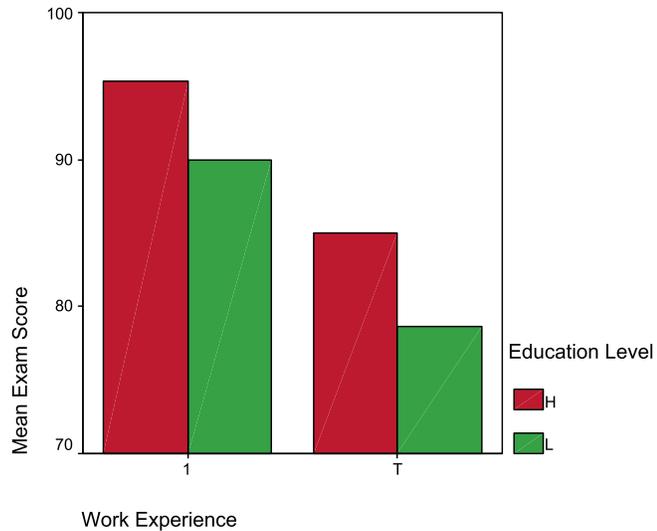


Figure 2. Estimated marginal means of exam scores

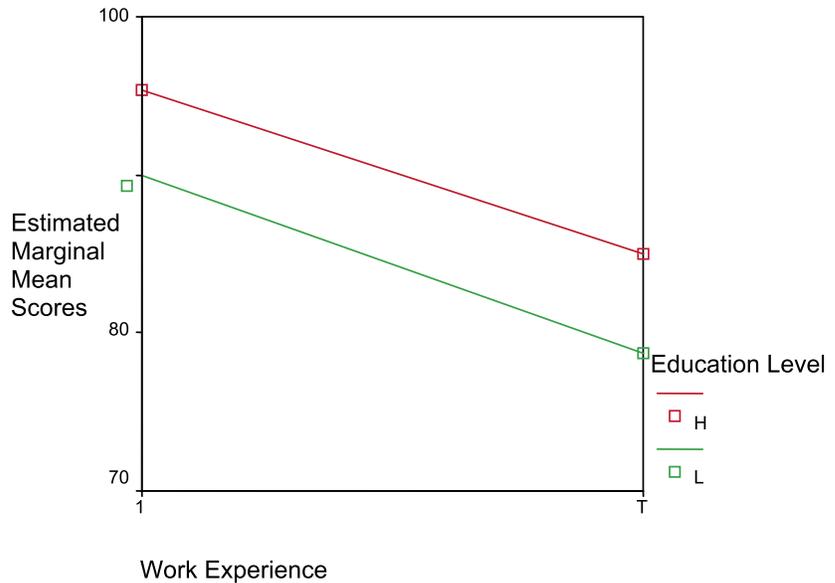


Table 4. Levene’s Test of equality of error variances

Dependent Variable: Exam Score

F	df1	df2	Sig.
1.778	3	38	.168

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept+EXP+EDU+EXP * EDU

= 24.862. The observed *F* value for analysis of interactions is $F_{test} = 0.175$.

Hypothesis Analysis

Hypothesis 1. The first hypothesis being tested was that there is no main effect for level of work experience on exam score. Using data from Table 5, the observed *F* value for work experience (EXP) is 85.617. Because this observed *F* value exceeds the *F* critical value of 4.10, the null hypothesis that there is no main effect for level of work experience is rejected. Supporting the rejection of the null is the observed significance level (Sig.) for work experience in Table 5 of 0.000, which is less than the established alpha (significance level) of 0.05.

Hypothesis 2. The second hypothesis being tested was that there is no main effect for level of education on exam score. Using data from Table 5, the observed *F* value for work experience (EDU) is 24.862. Because this observed *F* value exceeds the *F* critical value of 4.10, the null hypothesis that there is no main effect for level of education is rejected. Supporting the rejection of the null is the observed significance level (Sig.) for work experience in Table 5 of 0.000, which is less than the established alpha (significance level) of 0.05.

Hypothesis 3. The third hypothesis being tested was that there is no interaction effect among the level of work experience and the level of education on exam score. Using data from Table 5, the observed *F* value for the interaction effect (EXP*EDU) is 0.175. Because this observed *F* value is less than the *F* critical value of 4.10, the null hypothesis that there is no interaction effect among the level of work experience and the level of education is not rejected. Supporting the decision not to reject the null is the observed significance level (Sig.) for the interaction effect (EXP*EDU) in Table 5 of 0.678, which is greater than the established alpha (significance level) of 0.05.

The results of the study do not change when another ANOVA is run without the interaction effects of the two

independent variables. Table 6 shows only very small changes to the observed *F* values (87.369; 25.342) and no change to the significance levels when the interactions effect between the two variables is factored out. The alternate main effects hypotheses that state level of work experience and level of education do affect the final grade score received on a State of Wisconsin class S certification exam have received support from this study.

Conclusion

As the importance of certification continues to grow, the need to understand the determinants related to successfully passing a written examination will become increasingly critical. The purpose of this study was to determine the relationship of work experience and education on the final grade score earned by participants on the State of Wisconsin class S water operator certification exam. The two study variables (level of work experience and

level of education) were both identified as having statistical significance in relation to exam score. In terms of how an exam participant scores in relation to their level of work experience and their level of education, there is sufficient statistical evidence to conclude that there is a difference in the means. This signifies that the level of work experience and the level of education an exam participant possesses do have an affect on their earned score on a class S certification exam. In terms of the interaction effect of the two variables, there is insufficient statistical evidence to conclude that there is a difference in the means.

The results of this study show that there is evidence of a relationship among exam score, work experience, and education. This does not exclude other variables from having a similar statistical or practical significance in terms of direct relationship with exam score and the relational impact on the

Table 5. ANOVA results: Tests of between-subjects effects

Dependent Variable: Exam Score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2281.261 ^a	3	760.420	72.746	.000
Intercept	231811.531	1	231811.531	22176.461	.000
EXP	894.963	1	894.963	85.617	.000
EDU	259.889	1	259.889	24.862	.000
EXP * EDU	1.829	1	1.829	.175	.678
Error	397.216	38	10.453		
Total	324416.000	42			
Corrected Total	2678.476	41			

a. R Squared = .852 (Adjusted R Squared = .840)

Table 6. ANOVA results without interaction effects

Dependent Variable: Exam Score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2279.431 ^a	2	1139.716	111.388	.000
Intercept	317876.924	1	317876.924	31067.190	.000
EXP	893.955	1	893.955	87.369	.000
EDU	259.296	1	259.296	25.342	.000
Error	399.045	39	10.232		
Total	324416.000	42			
Corrected Total	2678.476	41			

a. R Squared = .851 (Adjusted R Squared = .843)

independent variables. Future research should try to identify and control for other significant variables such as type of education and work experience of participants that may influence the results of the study.

Significance of Findings

Statistical significance is a statement of probability and given the small size of the sample population and the fact that all sample participants scored high enough regardless of their level of work experience and level of education to pass the certification exam, the certainty that the results obtained by this study can be generalized as statistically significant to a larger population is marginal. Two important points were highlighted through the results of this study. First, the level of education an exam participant possessed does have a positive affect on the exam score received. This held true for both levels of work experience in that individuals who had a higher level of education scored higher on the exam whether they were categorized as having little or a lot of work experience. One may infer from this that a method of preparing for this certification exam would be to obtain a level of education rated as High by this study. This may not have a lot of practical significance as one would expect to score higher on any examination with more related education but when it would be practical is when employers hire certified operators according to their examination score. Employers often use certification exam scores as a means to screen job applicants much like schools use grade point averages and standardized test scores to accept and place potential students. In this sense, it is imperative to not just pass the exam as the sample participants did in this study but to pass the exam with a very high score. In addition, obtaining a higher level of education would be practical if career plans are to advance beyond the level of operator.

The second important point the results of this study uncovered is that the most significant determinant to a high certification exam score is the participant's level of work experience. Although

all sample participants in this study passed the certification exam, those that scored the highest were those with the higher level of work experience. This is significant in that it reflects well of the examination instrument being related to the occupational tasks it was designed to test and it highlights the importance of industry work experience in preparing for certification. This will also validate the practice of technical colleges in Wisconsin maintaining internships in occupational training program areas, such as Water Technology, that have certification entrance requirements.

Research Implications

The literature has shown that certification is important in many industries for a variety of reasons. It is mandated in the water industry in the State of Wisconsin that water operators be certified. A sound understanding of the certification exam process and variables that are related to success in passing the exam or scoring high on the exam is important to maintain occupational credibility and to enable educators and employers to best prepare the workforce for success. This research has shown that the level of work experience and the level of education have an affect on the exam score a participant receives.

Suggestions for Future Research

As the use of certification in industry is increasing, the need for understanding the exam process and participant variables that affect success grows in importance. While research on factors related to water operator certification exam success can proceed in numerous directions; several initiatives, using this study as a basis, could result.

Work Experience Level. The categorization of data in this study was rather ambiguous. A Grade T operator was an individual who possessed less than one year of industry work experience. Less than one year could be 11 months or it could be someone with no work experience at all. Future research could better categorize experience and gain a more robust insight into the effect work experience has on exam score.

Work Experience Type. This study did not breakdown experience on the basis of type of tasks performed while obtaining work experience. There are many different types of treatment designs and processes and many different job designations within water and wastewater operations. Insight into the type of tasks performed while on the job and testing their relationship with exam score would be beneficial to the certifying authority, potential exam participants, and employers desiring to get new employees certified.

Education Type. The categorization of education level for this study was relevant on a number of points as discussed previously but an expanded categorization could improve its significance. Education seemed to be less significant in terms of high exam scores than work experience but an expanded study would still be quite beneficial to all parties. Future research may be able to better break down and categorize the education variable to find narrower categories that are significantly related to exam score and exam success. The literature notes that education positively affects exam score and future research may be able to determine if education in a specific area or to a specific level is more significant than others

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