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ABSTRACT

The authors examined how many years of on-the-job experience are equivalent to the job preparation provided by the Associate of Applied Science (AAS) degree in Process Technology (PTEC). The authors examined records of 157 potential employees for their work experience, education, and job preparedness. Job preparation was measured with a validated pre-hire test. Authors examined scores on the pre-hire exam with years of experience as a PTEC operator, experience in related fields, PTEC education, and other academic education. Total years of previous work experience as an operator and years of PTEC education showed the strongest positive correlations to pre-hire test scores. However, each year of PTEC education was worth 5.3 years of job experience. Future research regarding additional dependent variables such as training completion time and starting wage are discussed.

PURPOSE

Employers want to know if job experience should be held above education or vice versa, and technical education institutions want to prove their worth by showing that their programs prepare students for the workforce in a way that the work environment cannot. The primary goal of this study was to examine the relative effects of on-the-job experience and job preparation provided by the Associate of Applied Science (AAS) degree in Process Technology (PTEC). Job preparedness can come from different sources including academic education, technical education, and work experience. Academic education is primarily seen as delivering cognitive development and problem solving competencies to students. Technical education attempts to replicate the workplace more directly than academic education. Experience provides the actual skills necessary to perform for the organization or industry but may be lacking in development areas more suited to education. It is difficult to compare empirically these learning environments, but industry representatives want to know which should be more valued when making employment decisions.

INTRODUCTION

Education and experience as a plan of job preparation have the same goal, to develop employees that can perform on the job and think critically. However, education primarily facilitates mental growth while experience fosters performance improvement (Geller, 2005). Employment decision-makers and employees differ in their opinion of which to value more. Gibson and Bamford (2001) noted that documented education qualifications were seen as more important than clinical experience by those making decisions for promotion and placement. However, employees within the program were not satisfied with this unbalanced recognition of experience in the field.

It seems universally understood that education plays an important role in job preparation for many fields. Academic education prepares future workers with problem solving and evaluation abilities and increases competence as well as confidence (Gibson & Bamford, 2001). Education is recognized as the best way to increase critical thinking skills that would ultimately be needed when reaching the top of any field, and experience may not provide this (Gibson & Bamford, 2001). However, educational curriculum can be disconnected from the actual work environment. Employers are less concerned that candidates have the cognitive ability to learn skills and want to know if they have the skills needed when they are hired (Prestwich & Ho-Kim, 2007).

Experience is seen as the practice needed to solidify required skills (Gibson & Bamford, 2001). Although some courses within an educational program may not be applicable to the job a graduate acquires, we believe experience on the job is directly relevant. In jobs where functional roles and work processes are specific to the industry, instructional curriculum must contain applied simulations of those specific work processes; however, it is our opinion that simulations are difficult for academic universities to accomplish since a program may target many different industries.

Jobs in technology are of special consideration when discussing job preparation. Technical education programs blur the lines between academic education and job experience by encompassing applied performance criteria in equipment lab environments that mimic job performance (Zwers, 2010). The AAS degree in PTEC is the primary technical education program for operator employment preparation within highly technical fields such as oil refinement, gas and chemical production, pharmaceutical manufacturing, and water treatment facilities. In programs like PTEC, teachers complete internships with their industry partners to stay abreast of technological changes and bring improvements back to the classroom for immediate inclusion (Harpole, Kerley, Silvernail, Kinard, & Brooks, 2010). Technical programs teach more than theory and information. They teach skills that can be applied on the job immediately. Because skills needed for jobs like PTEC are closely imitated in technical education classrooms, opportunities exist for success metrics that can be used in both environments.

A problem still remains that various schools may prepare a student differently, and experience in various jobs is likely to strengthen different skill areas. As well intended as some educational programs are, they may not be teaching what the field requires (Prestwich & Ho-Kim, 2007). Similarly, training programs in industry focus on one particular job in a field instead of the field as a whole. Experience with one employer may not equate to experience with another. A utility operator in a petrochemical field is not likely to receive the same equipment training or job experience as a production operator. For these reasons metrics for education and experience need to be universally usable in all work and education environments.

Standardized exams are used to measure an institution's ability to educate (Varughese, 2005). These exams can be used to compare similar educational programs from different schools. Many colleges already use exit exams on students in their last semester to compare their program with other schools (Varughese, 2005). These exit exams provide another way for programs to demonstrate their value. Some exit exams target specific job skills for students. These tests could also be used with workers relying on work experience as their form of preparation.

Businesses often use similar tests as pre-employment exams to ascertain job readiness of candidates. These performance tests are a category of pre-hire testing used to measure knowledge of a particular field (Ajila & Okafor, 2012). Pre-hire tests are used to compare multiple candidates including internal employees seeking new roles and external applicants (Giumetti & Sinar, 2012). A well-developed and validated pre-employment exam measures job readiness and knowledge that could be gained by experience or education (Ajila & Okafor, 2012). It is logical that education could be measured against experience by using such a test.

A comparison between education and experience must be able to identify which most readily provides a person with job related skills and knowledge within the same time frame. Employers want to know if two years spent completing a degree is equivalent to or better than two years of experience on the job (Prestwich & Ho-Kim, 2007). In this study the authors predicted job preparedness in the process technician field from the knowledge and skills gained each year a person worked toward the AAS degree in PTEC and each year a person gained experience on the job.

METHODOLOGY

Applicants

The authors collected data from archival records of candidates for employment within the petrochemical industry. Applicants were selected by use of the hiring process for a process operator job. Job openings were posted by standard means for the organization, which included listing the job on internet based job databases and solicitation for candidates via employment agencies. All candidates applying for the job between February 2006 and August 2011 were used. Applicants were informed that the results of the data collected would be used during the face-to-face interview with the hiring supervisor in order to ask questions about their experience and knowledge. The information was provided to applicants in order to encourage them to be honest about their history. Work history and education were verified for all candidates. There were 157 applicant records for this study. Information pertaining to gender, age, and ethnicity was collected but release of this information was declined by the organization providing the data. The current workforce has an age range from recent high school graduates to those well beyond retirement age. Approximately 43% of the workforce is 50 years of age or older ("The north American," 2013) and is predominately male.

Measures

Constructs for the study included the following independent variables: (a) PTEC education, (b) other education, (c) PTEC job experience, and (d) related job experience. PTEC education was defined as education toward the attainment of the PTEC degree. PTEC education was measured in school-years. Each year was equivalent to 30 semester credit hours of coursework. Other education was defined as any other post-secondary education not directed toward the attainment of the PTEC degree. It was also measured in school-years. PTEC job experience was defined as experience on the job in the process technician field. PTEC job experience was measured in years. Related job experience was defined as experience on the job in a related field. Related fields include but are not limited to jobs such as: Materials Handling, Plant Maintenance, and Blending Machine Operator. Related job experience was also measured in years.

The dependent variable for the study was a written test score achieved on a validated equipment and systems knowledge exam, the *General Industry Pre-Hire Test*. This test score was recorded for each applicant. The exam covered topics such as valves, piping, vessels, pumps, instrumentation, heat exchangers, cooling towers, steam generation and boilers, furnaces and fired heaters, utilities, and extraction and distillation. This test was measured by percentage from 0% to 100% of questions answered correctly out of 130 questions.

Procedure

On the same day as, but before the face-to-face interview, applicants to the job opening were asked to provide work and education history. Applicants were provided with instructions before beginning and were given details regarding the measurement of years in school and years at work.

Applicants were also informed of definitions such as related job fields to process technology. Once all terms were defined, applicants were asked years of experience in a petrochemical operator position, years of experience in related fields, whether they had an associate's degree, whether they had a one-year PTEC certificate, years of post-secondary education related to PTEC, and years of post-secondary education not related to PTEC.

The *General Industry Pre-Hire Test* specifically tested for knowledge of process technology information that an applicant may gain by working within the process technician field or by being a student within a process technology degree program. This exam was produced using a validation process as required by the Equal Employment Opportunity Commission ("Uniform guidelines on," 2008). The final exam received approval from a selected Subject Matter Expert (SME) team that the scope of the exam was subject matter comprehensive and representative of important aspects of performance in the process operator job (Johnson, 2010).

The validation process of the exam began by ascertaining the education and experience requirements of the process operator role by completion of a job analysis. *The General Industry Pre-Hire Test* was developed specifically to assess these requirements. Research was conducted on multiple testing and selection processes to determine the best device for this purpose. Options included chemical industry developed operator tests and various course exams developed and used by technical colleges within the PTEC degree program (Johnson, 2010). It was decided that a combination of these materials was to be used to develop the exit/pre-hire exam (Johnson, 2010).

The SME team was selected to review the materials, suggest changes, and make corrections. Based on SME scoring, some test questions were removed or changed. The validation process was considered by the SME team to have met or exceeded the intent of *Title VII of the Civil Rights Act of 1964* and its clarification doctrine the *Uniform Guidelines on Employee Selection Procedures (UGESP)* (Johnson, 2010). More specifically, this process was designed to comply with requirements of the UGESP covering content validity ("Uniform guidelines on," 2008).

After work and education information were collected, the pre-hire knowledge exam was conducted. Each applicant was given 90 minutes to complete the exam. Immediately upon completion, the exam was scored and taken to the hiring supervisor for use during the face-to-face interview. Table 1 has example questions from the exam.

TABLE 1: EXAMPLE QUESTIONS FROM THE KNOWLEDGE EXAM

Question #	Question with Answer Options	Correct Answer
33.	Hydraulic shock is caused by a. too much fluid flowing through a pipe b. pressure surges that occur when a valve is closed rapidly c. solid particles banging against the flow control element	B
47.	In a heat exchanger that uses steam for heating, why is the condensate that is formed removed? a. To prevent corrosion b. To prevent it from accumulating and interfering with heat transfer in the heat exchanger. c. To control the amount of steam entering the heat exchanger. d. To control the amount of steam leaving the heat exchanger.	B
115.	What causes hardness in water? a. Dissolved gases, such as oxygen and carbon dioxide b. Suspended solids c. Calcium and magnesium ions d. Dissolved salts, such as sodium chloride	C

FINDINGS

The main dependent variable in the analysis is the GI Pre-Hire Test Score. Percent scores ranged from 28 to 93. The mean (*M* = 64.6, *SD* = 14.6) was very similar to the median (Median = 66.0).

Next we correlated the GI Pre-Hire Test Scores with the four main predictors: years as an operator, years in a related field, years of process technology education, and years of other college. Table 2 lists the means, standard deviations, and medians as well as the correlations with the Test Scores. All the predictors have a positive skew such that the median is always lower than the mean. Likely the higher means are caused by workers having experience from one or two predictors but not high levels of all predictors. In fact, the relation between years as an operator and years in process technology education is negative, $r(157) = -.25$, $p = .002$. The median of 0.0 for years in related field and years in process technology education indicates that more than 50% of the sample did not have either of these experiences.

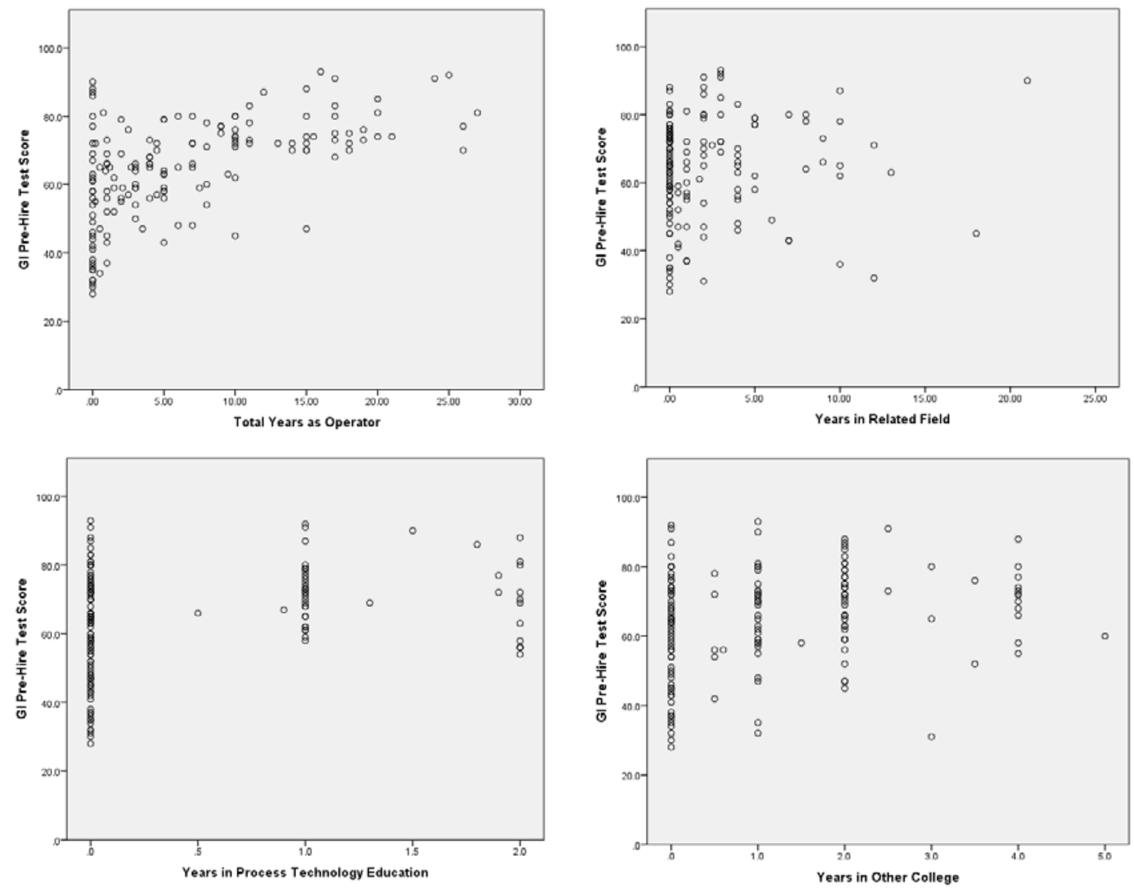
TABLE 2: RELATION OF PREDICTORS TO GI PRE-HIRE TEST SCORE

	Mean (SD)	Median	r with Test score
Years as Operator	6.6 (6.9)	4.0	.55
Years in Related Field	2.2 (3.6)	0.0	.05
Years in Process Technology Education	0.4 (0.7)	0.0	.27**
Years in Other College	1.2 (1.3)	1.0	.24*

Notes: * - p < .05, ** - p < .01, *** - p < .001

To get a clearer picture of the relationship between the GI Pre-Hire Test Scores and the four main predictors, we examined the scatterplots of each predictor and the Test Scores. These scatterplots are in Figure 1. The scatterplot with Years as Operator shows that when operators have no experience, there is a high variability in Test Scores; however, once operators have experience, especially more than 10 years of experience, almost all the scores are above the median. As indicated in Table 2, the correlation between Years in Related Field and Test Scores was not significant. This lack of relation is illustrated in the scatterplot where no matter how much experience in a related field, there are individuals who score high and low on the Test Score. The scatterplot for Years of Process Technology Education shows most workers have 0, 1, or 2 years of education. A few workers had partial years. The scatterplot indicates that workers with 0 years of education have a wide variability of scores, but workers with 1 year of education or more tended to score at least 55 or above. Test Scores with 1 year of education were similar to performance for workers with 2 years of education. As indicated in Table 2 there was a positive relationship between Years in Other College and Test Scores; however, higher scores were not as consistent with more education until workers had at least 4 years of education.

FIGURE 1: SCATTERPLOT DIAGRAM



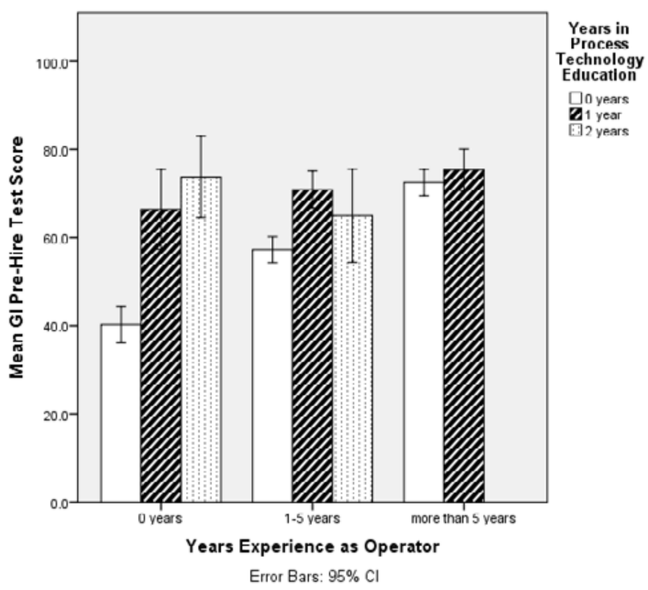
Scatterplot diagrams showing relation of Pre-Hire Test Scores with Total Years as Operator, Years in Related Field, Years in Process Technology Education, and Years in Other College.

From these analyses it appears the two predictors that show the clearest relationship to the GI Pre-Hire Test Scores are the Years as an Operator and Years in Process Technology Education. There are a few methods to compare the relationship of these predictors with the Test Scores. First, we used regression to predict Test Scores for each of the two predictors. The resulting regression equations were: Predicted Test Scores = 57.04 + 1.15 * Years as Operator and Predicted Test Scores = 62.10 + 6.09 * Years PTEC Education, respectively.

Both predictors are significant (both *F*'s > 10, both *p*'s < .01) indicating the more one has been an operator and the more one has been in process technology education, the higher the predicted test score. However, it does appear from the *b*-weights that a year in process technology education would increase the predicted score much more than a year as an operator. The ratio of the *b*-weights is 5.3 indicating that a year of process technology education is roughly equivalent to 5.3 years of experience[1].

Given that the effect of these two predictors may not be independent of each other, we also examined the predictors in combination. Examining the scatterplots and the regression analysis we decided to divide the Years as an Operator into three groups rounded to the nearest year of experience: 0 years, 1-5 years, and more than 5 years. We also split the Years in Process Technology Education into three groups: 0 years education, 1 year education, and 2 years education. Combining the two variables created nine categories; however, no workers had both 2 years education and more than 5 years of experience. Therefore, only 8 categories were used in the analysis. The mean and 95% confidence interval for each of the resulting eight groups are in Figure 2.

FIGURE 2: YEARS EXPERIENCE AS OPERATOR



Average GI Pre-Hire Test Scores by Years Experiences as Operator and Years Process Technology Education. Error bars represent the 95% confidence interval for each group. No potential workers had both more than 5 years of experience as an operator and 2 years of process technology education.

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[1]When we placed both predictors in a multiple regression, the resulting ratio of the b-weights was 7.0. When we placed all four predictors in a multiple regression, the ratio of these two b-weights was 6.5.

We then ran a 2-way Analysis of Variance (ANOVA) on these categories. Overall, there was a main effect of Experience as an Operator, $F(2,149) = 29.9$, $p < .001$ and a main effect of Education in Process Technology, $F(2, 149) = 38.6$, $p < .001$, such that the more education or experience, the higher the predicted Test Score.

There was also a significant interaction between experience as an operator and education in process technology, $F(3, 149) = 12.5$, $p < .001$. To further investigate this interaction we examined the simple effects for each level of experience as an operator. With no experience as an operator, process technology education had a significant effect, $F(2, 149) = 46.0$, $p < .001$. Examining the pairwise comparisons within the three levels of education showed higher Test Scores for workers with 1 or 2 years of education over those with 0 years of education (both *p*'s < .001), but no significant difference between those with 1 or 2 years of education ($p = .12$). With 1-5 years of operator experience, there was also a difference between the three education groups, $F(2,149) = 9.69$, $p < .001$. Pairwise comparisons indicate a significant difference between 0 years and 1 year of education ($p < .001$) but not between 0 years and 2 years of education ($p = .07$) or between 1 and 2 years of education ($p = .22$). For the group of workers that have more than 5 years of experience there is no difference between the two levels of education, $F(1, 149) = 0.96$, $p = .33$. In summary, education made the most difference on Pre-Hire Test Scores when the worker did not have any experience as an operator, and education did not make much difference once the worker had more than 5 years of experience.

IMPLICATIONS

For workers without much experience, one year of PTEC education provides more job relevant competence than the same amount of time gaining experience on the job in the process technician field. Overall, PTEC education outweighed work experience at a 5.3 to 1 ratio.

Participants in this study were candidates for employment as operators within highly technical operations such as oil refinement, chemical production, power generation, and more. These jobs are available around the world, and there is a high concentration of need in the United States. Numerous technical colleges have PTEC degree programs specifically for this need, and industry continues to raise the bar for hiring requirements.

Organizations such as the college and industry members of the North American Process Technology Alliance (NAPTA) would greatly benefit from the outcomes of this study. NAPTA is a 501c3 nonprofit organization that brings technical colleges, industry members, and government entities across North America together to set standards for education within the AAS degree in PTEC ("The north american," 2013). NAPTA hosts 31 member colleges such as Lamar Institute of Technology, Northeastern Oklahoma A&M, South Arkansas Community College, and San Jacinto College. Furthermore, NAPTA provides endorsement for colleges that are aligned with core PTEC curriculum and audits those programs. NAPTA also has 24 industry member organizations such as Shell Oil, Marathon Petroleum, BASF, Valero Energy, Dow Chemical, ConocoPhillips, DuPont, and ExxonMobil. Each college and industry member sends multiple stakeholders to NAPTA meetings to discuss and collaborate specifically regarding the knowledge and skill requirements of the PTEC field.

The results suggest that industry should put a high priority on hiring candidates that have attained education toward the PTEC degree and should strongly consider this program's value as it compares to job experience. Those seeking to enter the process technology workforce should consider the PTEC degree program as their first step toward this career path.

Another interesting finding is that it appears a one-year certificate may be as good as two years of education. Pre-hire scores for potential employees with one year of education are equivalent to those with two years of education. Potentially, the one-year certificate concentrates on PTEC courses while a two-year AAS degree also adds complementary academic courses such as Technical Writing and as well as some overall requirements for the AAS degree such as a course in humanities.

One limitation of the research was the fact that there may be other differences between people who acquire the degree and those who do not, and these differences could account for differences in performance. However, the authors contend that potential employees with an AAS degree in PTEC and potential employees with years of job experience are similar to the groups the authors used in this analysis. Likewise, the authors would caution that just providing education to individuals may or may not be effective with potential employees who were not planning on getting post-secondary education.

A second limitation with this study is that potential employees were measured on a pre-hire test. Although the authors believe the test has predictive validity with job performance, the authors do not have the data to empirically verify this claim. Similarly, this pre-hire measure may not be predictive of other employment measures such as retention. Additionally, other predictors independent of this pre-hire test, such as personality or motivation may also contribute to higher job performance.

Future research is suggested regarding training completion time and starting wage. Originally the authors intended to include these variables; however, while conducting the research, the authors discovered that training time was affected by the leeway provided to participants during the inception of the program regarding the training requirements' mandatory completion. It was determined that this flexibility would result in an unrepresentative picture of the actual time needed to complete training by a large number of participants. Thus, this variable was removed from the analysis. Starting wage was also removed from the analysis. During data collection, the organization experienced significant reclassification of operator jobs and changed the job classifications. Additionally, starting wages were distorted by annual wage increases and cost of living wage increases that were applied throughout the data collection date range.

In conclusion, the authors have presented evidence that job candidates with education in the PTEC field are more prepared for work than individuals who have an equivalent amount of work experience. In fact, according to the analysis, a two year AAS degree is equivalent to approximately 10 years of work experience. The authors encourage other applied fields to conduct similar analyses to determine if this trend is specific only to PTEC or if it is typical across many applied fields that offer an AAS degree.

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