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Recommendations on Skill Evaluation of IT Computer Professionals and Recent IT Program Graduates

Based on the Comparison of Test Results from Various Student Groups

Abstract

In the present economic conditions many laid off seasoned IT professionals opt for upgrading their skills in order to return back to the active workforce. At the employment screening and interviews these professionals are evaluated using the same procedure as the recent college graduates. Being older and often far removed from their College/University education, these workers often exhibit poor results during the employment screening tests. The results of the tests presented in this paper show that if memorizing component is taken out of testing these professionals can perform at the same or even better level than recent college graduates. By altering the tests to exclude the necessity for memorizing the hiring companies can take into consideration those candidates who would otherwise be screened out by the standardized computerized testing.

Introduction

The process of managing financial decisions in the IT sector in the last decade was influenced by the multitude of financial, business and social crises starting from the infamous dot-com bust of the early 2000s (Lewellen, 2003), followed by the IT downturn connected to the events of September 11, 2001 (Posner & Vermeule, 2008) and the financial crisis, which started in 2007 (Pezzuto, 2008). In the view of these events a large number of IT companies are considering bringing their IT functions back in-house in order to preserve costs and have better control over the development efforts (Beardsell, 2010).

In the North American IT scene we see that many skilled IT professionals attempt returning back to work. A large number of them according to (Tennant, 2008) are being retrained to obtain new skills related to the new technology offerings from Microsoft, Oracle, IBM, etc. Although they are well qualified to perform general IT duties these workers can at the same time be considered by many as newcomers to the industry due to the lack of working experience with the skills they had recently acquired (Hoffman, 2005). HR professionals and hiring IT managers must decide on how to classify these members of the workforce and how to approach them in the best possible way in order to make the most correct decision from human resource and business perspective (Gatta, 2008).

According to the case study (Gorman, 2011) related jobs often require the presence of two different and very disjointed skills. Any member of the IT stuff, who develops and supports IT applications, has to be aware of the business processes, which these applications are designed to implement (Collett, 2010). In this capacity the mentioned member of the IT stuff has to possess an experience that cannot be taught in any computer school. Hence the professional IT vacancies are best to be filled by the experienced personnel with the prior knowledge of the subject matter. On the other hand, the complexity of today's IT systems requires proficiency in the most up-to-date technology (Lee & Mirchandani, 2010). The combination of the described two skill sets is ideal in the job candidate. However, in todays cash-strapped IT world the individuals possessing both skill sets may be out of the financial reach of many organizations, which decided that they would take a financially lean approach to their hiring process[1].

Bound by the aforementioned constraints the IT management often retreats towards the second most obvious solution: hiring the latest graduates from the IT training schools and melding them into the working environment by teaching them business skills required to succeed in the IT branch of the particular organization. IT training schools

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[1] According to ComputerWorld Web IT Salary Calculator available at http://www.itworldcanada.com/salarycalculator/result.aspx the salary of the very senior technical resource is $91-$115K whereas the salary of experienced computer programmer is $65-85K and the salary of entry level programmer is $45-$55K in the year terms

today perform a dual function: they educate high school graduates who decided to make Information Technology into their career and retrain those who are already a part of the global IT community but lost their employment due to downsizing connected with the recent financial crises. There is a good chance that members of the second group already have the required "soft" (business) skills. The question remains whether they would be able to catch up with the new technology in the new IT environment.

Many employers today try to examine their perspective candidates before bringing them in-house for the face-to-face interview. In (Karten, 1982) the discussion is centered on the aptitude tests. It can be argued that the role of aptitude tests of the 80s when the article was written is very similar to the technical screening performed today. Many of the technical skill evaluations resemble the subject exams taken at the high school and diploma levels[2]. Former high school and even university students who recently graduated from the IT programs have acquired a formidable skill of passing these exams with relative ease. However, (Spiller, 2004) states that a large number of students cannot correlate their knowledge with real life situations. On the other hand the re-trained workers who are often much older and do not have as good a memory often stumble over those exams. Because of the fact that those skill tests are often conducted by the third party over the Internet it hard for the hiring managers to appreciate the extent of the real skills of those who took the mentioned tests and were brought for the face-to-face interview based on their test scores[3].

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[2] Brainbench company http://www.brainbench.com offers the results of the tests taken on the company website to the prospective employers. The company also offers tests tailored to the needs of the specific company.

[3] The company called "Prove It!" http://www.proveit.com/default.htm offers tests tailored to the employers needs. The company offers test website where candidates can be sent by the prospective employers to pass skill tests

Experiment Description

The study described further in this paper is based on the data collected during the exams of the students of the Information Technology Solutions (ITS)[4] program and the exams of the Re-trained international IT professionals who have a proven experience in the field but had to be reeducated on the new technology skills to be employable in the Province of Ontario, Canada[5]. The students of the ITS program are the recent graduates of the foreign Universities and Colleges. The vast majority of them do not have any work experience and their study process (high school-college-ITS) was practically uninterrupted.

The participants of the re-training program also have international IT experience. They were offered an entry exam which confirmed their knowledge of programming and suitability for the program. The quality of the skills in the group can be proven by the fact that by the end of the six months course seven of these IT professionals found a job based on the skill set they possessed before entering the program.

The members of both control groups were trained in the subject of C# development.   The regular college course "Introduction to C#" was based on three hours a week of study over 15 weeks (45 hours in total). Students were subjected to the regular midterm and final exams upon that their subject grade was determined.

 The students (professionals) of the second group had a condensed program, which is typical for the type of training they underwent. The course was delivered in three-hour sections four days a week over five weeks (60 hours in total). The participants had a test in each of the first four course weeks. The final exam taken at the end of the fifth week was practically identical to the final exam of the ITS course.

Both groups were taught by the same member of the college faculty. The same professor created the tests and graded them. The questions on the tests required short answers. No multiple choice questions were given. The study presented in (O'Neill, 2004) clearly shows that the students who take essay style exams usually better correlate the subjects with real life. Both groups of students were given the same two-period interval to complete the tests. The marks were computed out of 100%. The total mark was calculated by dividing the number of correctly answered questions to the overall number of questions. The partially answered questions were getting partial marks (in the fractions of one). The sample questions can be found in the Appendix.

Results of Experiment

The experiment yielded the following results. Table 1 contains the results obtained from examining the students the students of both programs.

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[4] ITS program is offered by Humber College of Toronto Ontario. The description of the program is available at http://www.humber.ca/program/information-technology-solutions
[5] Humber College offers the programs within "Second Career" option provided by the Government of Ontario. The particulars of the program are available at http://www.humber.ca/secondcareer/

Table 1.

IT Professionals						ITS Students	
Week 1	Week 2	Week 3	Week 4	Final		Midterm	Final
0.80	0.79	0.82	0.89	0.73		0.82	0.72
1.00	0.73	0.75	0.93	0.83		0.74	0.66
0.85	0.80	0.85	0.97	0.88		0.85	0.60
0.57	0.40	0.60	0.79	0.82		0.76	0.60
0.93	0.67	1.00	0.93	0.90		0.77	0.72
0.67	0.40	0.65	0.97	0.75		0.89	0.81
0.55	0.43	0.71	0.60	0.73		0.77	0.62
0.82	0.67	0.85	0.97	0.78		0.77	0.70
1.00	0.83	0.98	1.00	0.93		0.88	0.70
0.67	0.80	0.73	1.00	0.78		0.81	0.63
0.77	0.53	0.75	0.93	0.97		0.88	0.51
0.91	0.73	0.80	0.93	0.91		0.78	0.71
0.91	0.73	0.96	0.97	0.87		0.44	0.55
0.39	0.65	0.35	0.63	0.69		0.80	0.46
0.91	0.91	0.85	0.97	0.77		0.83	0.61
0.72	0.93	0.85	1.00	0.80		0.74	0.53
0.77	0.87	0.85	0.87	0.90		0.84	0.78
0.54	0.47	0.55	0.87	0.72		0.72	0.66
0.83	0.87	0.88	0.87	0.83		0.83	0.56
0.81	0.87	0.83	1.00	0.97		0.80	0.69
0.79	0.67	0.75	0.87	0.80		0.70	0.78
0.75	0.65	0.29	0.95	0.80		0.71	0.58
						0.82	0.53
						0.66	0.64
						0.88	0.92
						0.73	0.52
						0.50	0.46
						0.76	0.63

During the course of experiment the first three tests were written by IT professionals were based on the same principles as the ones used for the students of the ITS program, i.e. all materials were to be memorized and no books/laptops were allowed. During the last two tests the IT professionals were allowed using books and computers.

Goals of Experiment

The main goal of the experiment was to prove the following two hypotheses:

1. *The students who were studying contiguously despite having little or no experience at all can outperform the seasonal IT professionals on the tests that rely solely on the memory.*

2. *Given the opportunity to use any available materials (books, internet, course slides, etc.) the IT professionals will perform at least not worse than the students.*

Goals of Experiment

Evaluation of Data

During the evaluation process the following set of tools was used to evaluate the data and to create a basis for successful check of both hypotheses (Lind et al, 2002):

- The distribution of marks was constructed based on the presented population for each test. The mean and the standard deviation were calculated for each population.

- The test of the normality of the distribution was conducted in order to verify that the results are not sufficiently skewed by an external influence. Normality tests are performed based on Kolmogorov criteria (Pustylnik, 1968). One of the corollary of Kolmogorov theorem states that Skew and Kurtosis of the distribution adhere to the following rules:

  $|S| \leq 3 * \sqrt{D(S)}$ and $|K| \leq 5 * \sqrt{D(K)}$ where

  $D(S) = \frac{6*(n-1)}{(n+1)(n+3)}$ is a variance of Skew and

  $D(K) = \frac{24*n(n-2)(n-3)}{(n+1)^2(n+3)(n+5)}$ is a variance of Kurtosis

  Here n is the number of elements in the population and S and K are the values of Skew and Kurtosis of the population respectively.

- For the evaluation of the hypotheses listed previously we use the criterion of Fisher, stating that for any $F = \frac{\sigma_1^2}{\sigma_2^2}$, where σ represents standard deviation of the population, the factor would be influencing the difference in the results if F is greater than the value of the Fisher distribution based on degrees of freedom of both populations and the given significance level.

- For the evaluation of the independence of the population results we calculated the correlation between the populations based on the time-adjacent tests.

The results in the Table 2 show the calculation of the previously described values. The significance level of 0.95 was used in the experiment

Table 2.

	IT Professionals					ITS Students	
Population Mean	0.771591	0.700227	0.756970	0.904545	0.824697	0.767142	0.639357
Standard Dev	0.157094	0.164859	0.180622	0.108562	0.080931	0.102915	0.108527
KURT	0.304749	-0.66673	1.63436	3.196409	-0.86577	3.877789	0.375814
SKEW	-0.7266	-0.58731	-1.27011	-1.84892	0.241044	-1.7537	0.516409
5* SQRT(D(K))	3.747995	3.747995	3.747995	3.747995	3.747995	3.562669	3.562669
3* SQRT(D(S))	1.404341	1.404341	1.404341	1.404341	1.404341	1.2735	1.2735
CORR		0.547932	0.501075	0.450811	0.481624	0.39084	
Variance(IT Prof)	0.024678	0.027178	0.032624	0.011786	0.00655		
Variance(IT Stud)	0.010592	0.011788					
Fisher(Prof, S1)	2.330015	2.566048	3.080219	1.112753	0.618409		
Fisher(21,27)	1.9	1.9	1.9	1.9	1.9		
Fisher(Prof,S2)	2.093522	2.305598	2.767581	0.99981	0.555642		

Evaluation of Results

The mean values calculated for each sample provide the first level of comparison of the test results of IT professionals and college students. It can be observed that in the tests where IT professionals could not use any additional materials the population mean is in the same range with the population mean of the sample of student marks. In the tests where professionals were able to use books and computers the population mean rises and the standard deviation of the observed population of marks is very close to the one observed in the population of student test marks. Given that variance is almost the same (when professionals can use additional aid) it is possible to assert that probability of finding a good skill match in the mature professional group is the same or higher than the probability of finding a skill match in the students' group.

When the subject was unfamiliar to both groups (final exams) the IT professionals (using additional sources of information) exhibited mean values of scores being in the same range as student mean values of student scores. This fact supports the findings from the first experiment. It is possible find the extremely good (close to 100%) and extremely bad scores in both groups. However the probability of bad scores should be very low based on the successful evaluation of the normality of the distributions based on the test result samples.

Based on the Fisher criteria it can be said that with at the significance level of 0.95 the age and the lack of the examination practice of the internationally trained IT professionals is a significant factor which influences the results of the experiment. The comparison of the ratio of variances of the first three tests passed by IT professionals to the variances of the marks of students' midterm and final exceeds the value of the Fisher distribution at the given significance level.

It is also important to note that the value of standard deviation for the marks, obtained by the IT professionals is much higher than the one of the student groups. It shows that if professionals have knowledge of the particular subject, they are able to retain it and to exhibit in the examination-like circumstances. However, if the knowledge has not been present previously it is not likely to appear at the examination time. IT professionals have neither will nor desire to "cram" before the examinations which is what regular college students often do.

The examining of the first three tests of the IT professionals group and comparing variances of these tests with the variances of the midterm and final exams written by the students actually proves the Hypothesis 1: Placed under the same (college style) examination circumstances and given the same exam style questions students and mature professionals will have marks (exam results) distributed quite differently. It means that the ability to pass exams and the recent experience in passing the exams comprise a significant factor which influences the results of the tests.

Examination of standard deviations reveals a very interesting phenomenon. The regular ITS students had a large overlap in the courses whereas they could rely on the previous knowledge in their midterm examination. In their final exam they had to answer the questions and solve the problems they haven't encountered before. It is important to note that the regular students give up much easier when they are met with the larger challenge. It can be observed that based on the Kolmogorov criteria the distribution of midterm marks is skewed towards the higher numbers. The distribution of the final marks follows the normal distribution very closely.

Elimination of the memory factor (tests 4, 5 of the IT Professionals) yields very interesting results. Firstly the IT Professionals exhibit the distribution of marks that still follows the normal pattern. It means that those who performed badly at the beginning started performing better but the average increased only slightly. This proves that by giving the seasoned professionals the opportunity to use textbooks we only eliminate the necessity to remember the rules and the facts but we do not help them to better understand the material and to solve the problems faster and with higher degree of correctness. However, the permission to use books eliminated the memory factor and placed IT professionals if not at the same level than higher than the college students. This effectively proves Hypothesis 2, that by elimination of the memory factor the students and the IT professionals exhibit very similar distribution of results.

Additional experiment

At the end of the training program for the IT professionals it became possible to obtain additional data that could serve as a verification of the previous findings. The last subject taught within the training program was very similar to one of the subjects taught to the students of the second year of the ITS program who have little or no working experience. The significance of the obtained data was that both groups (except for very few individuals) had absolutely no prior knowledge of Windows Communication Foundation (WCF), which was the subject of both courses. The results of the experiment are summarized in Table 3.

Table 3.

	IT Professionals				ITS Students	
Population Mean	0.791875	0.760625	0.790313	0.821313	0.772667	0.821333
Standard Dev	0.073504535	0.076722	0.08125	0.084189	0.114796	0.104599
KURT	-0.745626458	-0.90632	1.465655	-0.99828	0.599095	-0.76132
SKEW	0.010939858	0.011716	-0.27887	-0.15492	-0.61041	-0.0738
5* SQRT(D(K))	3.892565609	3.892566	3.892566	3.892566	1.620185	1.620185
3* SQRT(D(S))	1.677050983	1.677051	1.677051	1.677051	3.903124	3.903124
CORR		0.303593	0.220811	0.208942		0.341135
Variance(IT Prof)	0.005402917	0.005886	0.006602	0.007088		
Variance(IT Stud)	0.013178	0.010941				
Fisher(Prof,S1)	0.409995194	0.446672	0.500953	0.537844		
Fisher(14,15)	2.5	2.5	2.5	2.5		
Fisher(Prof, S2)	0.493822929	0.537999	0.603378	0.647812		

During the second experiment IT Professionals were allowed to use computer during the exams starting from the first test onwards. The students of the ITS program were passing exams regularly without the possibility of using any sources of information during the exam. The results show that the mean of the marks population is very similar in both cases. Both distributions are very close to normal and there is no correlation between the conducted tests.

The application of the Fisher's variance test shows that under the given circumstances there is absolutely no difference between the tests on the significance level of 0.95. Given the opportunity of using all information sources during the exams, experienced IT professionals would perform very similar to the college students which would yet again prove the Hypothesis 2. As a corollary of this test we can note that standard deviation of the results shown by IT Professionals is somewhat lower than the one of the students. This observation correlates with the observation made during the first experiment when all sources were allowed during the exam.

Comparison of Experiments

During the course of observations the following hypothesis was also considered: *The IT Professionals of the same group will show the same performance during the tests under the same circumstances regardless of the subject.*

In order to validate this hypothesis the variances of the tests were compared to each other with the help of the Fisher variance tests. The test results produced during the WCF course were compared with the test results produced during the C# course with and without the use of the materials during the test. The values of variance tests are compiled in the Table 4.

Table 4.

Fisher(21,21)	2.1	2.1	2.1	2.1
Variances (Pro WCF)	0.005403	0.05886	0.006602	0.007088
Variances (Pro C#, No Sources) T1	0.024678	0.027178	0.032624	
Variances (Pro C#, W/Sources) T2	0.011786	0.00655		
Fisher(T1, T2,1)	2.093840149	2.305956	2.76803	
Fisher(T1, T2,2)	3.767633588	4.149313	4.980763	
Fisher(21,15)	2.3	2.3	2.3	2.3
Fisher(WCF, T2,1)	2.181380714	0.200238	1.785217	1.66281
Fisher(WCF, T2,2)	1.212289469	0.111281	0.992124	0.924097

The comparison of variances of C# test results with and without the use of the additional sources show clearly that use of the additional sources of information during the exam is a significant factor influencing the results of the exam for the IT Professionals. Comparing the variances of the results obtained from the tests of C# and WCF passed with using the additional sources of information show that there is no significant difference in the variances of these results. Hence we can conclude that with the significance level of 0.95 that the subject of the exam does not bear significant influence on the results of the examination performed with the use of additional sources.

The results from the Table 4 also prompt us to conclude that using the additional sources of information can significantly alter the variances of the result of the exam. It effectively proves that Hypothesis 3 is correct.

Discussion of Results

The present and recent past economic conditions are the source of a large number of layoffs in the IT industry based on (Kshetri, 2007). During these layoffs IT professionals, who possess good domain knowledge and multiple years of industry experience are receiving unemployment benefits and are eligible to participate in the government sponsored training programs. The goal of these programs is to help these professionals to return back to the workforce. The experience in software development and IT support these candidates already possess would have made them the prime candidates to fill the new industry vacancies. The lack of knowledge of the new technology is the main reason for their participation in the retraining programs.

(Blank & Barratt, 1988) state that three or four interviews can be considered a standard practice and the majority of the interview process must be dedicated to figuring out the potential of the candidate rather than its current abilities. In order to be invited to the second and third level in-house interviews the candidates must often undergo computerized skill test screening. The results of the screening tests often become the only criterion for the invitation to the next level of interviews. While company may view a mature professional as a suitable candidate for the opened position, they often change their mind based on the poor results of the screening tests.

The comparison of the test results of the group of students without any working experience and the group of mature professionals shows that given the opportunity to use the additional sources of information during the tests mature professionals can pass the tests with the same results as the students. While professionals clearly lack the capacity and the will to memorize facts, that are the base of the answers to the questions, they do have an ability to understand the questions and apply the main ideas of the subject for which the test is conducted. The results of the experiment and the subsequent proof of the hypotheses stated earlier leads to the following corollaries:

1. The mature professionals have better ability to adapt to the testing. This adapting is based on their experience in the workplace and the prior knowledge of the computing subjects (other than the ones they are tested in).

2. Given the opportunity to use additional sources of information, which is available in the workplace in the form of books, e-books and Internet sources mature professionals can close the gaps in their knowledge at least as fast as the students. The results of the tests show that the standard deviation of the marks distribution of the mature professionals is two times larger when they memorized the answers as compared to the cases when they used information sources.

3. The use of the additional sources of information does not yield the highest marks to all of the mature professionals participating in the tests. There are marks that are lower than the population mean. Given that in the case of the candidate selection 75% result would quite often be sufficient for the invitation to the next

interview; there are still a number of candidates who'd be fallen well below this threshold even with the use

of the additional information sources.

In the view of the discovered corollaries it is possible to assert that by giving the exam style qualification tests to the mature candidates the company is risking discarding those who do not possess great memory skills but would otherwise well suitable for the tasks at hand.

Companies hiring computer programmers today juggle between two sets of requirements: soft (domain knowledge) skills and hard (technology) skills. This paper is not set to determine whether mature professionals or college students have different levels of soft skills. However, it is important to note that domain knowledge is never screened first. Starting screening from the technical skills allows companies to automate and streamline the process (Oshiro, 2010). However, this approach also puts those who may otherwise succeed in doing the job into disadvantage if they are not able to memorize major computing constructs (Morningside College, 2006).

The companies usually have the unwritten requirements to the years of experience and maturity of the candidates applying to a certain position. It can be suggested that if the company is set to hire a college graduate then straight examination style testing might be a screening procedure of choice. However, if the company is willing to consider a recently retrained mature professional, then by altering the screening procedure from exam style testing to the technical interview the company may be able to "salvage" candidates who would otherwise fail. Since many tests today require straight memorizing of the software constructs the companies using these tests may end up with the candidates who were the best at passing the tests but who are not suitable for doing the job at hand.

The results of the experiments reported in this paper show that in the job market conditions, creating a so-called employers marketplace, the approach towards testing of the candidates who apply for the relatively low level technical positions should be altered in order to give a consideration to those IT professionals who have enough overall experience in the marketplace but have to apply for the positions in the areas that are new for them and that were a focus of their training. By changing the questions from requiring straight (out of memory) answers to the ones calling for the understanding of the subject the screening party may allow all candidates to use any possible source of information. The results of the experiment show that even if all information is available during the test there would still be a significant number of candidates who would fail the screening. Employers who change their approach may be able to successfully evaluate the members of the workforce with the large practical experience, who chose to take advantage of the government programs and obtain new skills and who applied to entry level positions. The successful passing of the screening tests would not lead to hiring of the individual but it would let them the opportunity to present all of their skills and experience to the hiring company during a more meaningful next level interview.

Appendix

Samples of questions given to both groups during the tests:

1. What are form wide keys? List keys you know. Why do we use them?
2. What are three types of passing parameters to a method?
3. What is a custom event handler? What is the main difference between default and custom event handlers?
4. Why do designers use inheritance concept?
5. You have the following code. What is the outcome of it?

```csharp
class A
{
    public A()
    {
        Console.WriteLine("In A");
    }
}
class B : A
{
    public B()
    {
        Console.WriteLine("In B");
    }
}
class Program
{
    static void Main(string[] args)
    {
        B b = new B();
    }
}
```

6. You have the following interface

```csharp
interface X
{
    int g(int a, int b);
    int h(int a, int b);
}
```

You were asked to implement method g and leave method h unimplemented in your class. Please write the code doing this.

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