Industry Demand for Community College Graduates in Advanced Technological Education: Estimates from a National Employer Survey in Optics and Photonics Technology

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Abstract

The National Science Foundation in the United States has supported technician education through the Advanced Technological Education (ATE) program since 1992 to provide resources to U.S. two-year associate-degree granting colleges to expand the pool of skilled technicians in strategic advanced-technology fields. The intent of the program is to increase productivity of the Nation's industries and improve national competitiveness. The present study utilizes information collected from a national sample (n = 636) of optics and photonics technician employers to examine the demand for technicians. Despite conducting the survey during one of the worst global recessions, demand and compensation for technicians is quite high, and employers generally prefer to hire technicians with education represented by a one-year certificate or two-year associate degree.

Keywords: technician, employment demand, photonics, NSF, community college

1. Introduction

High technology employment is estimated to represent 14% of all jobs in the United States (Hecker, 1999; Jenkins, Leicht&Jaynes, 2006; 2008) and is projected to grow faster than other employer segments of the workforce (Hecker, 1999, 2005b; Bureau of Labor Statistics [BLS], 2009a).

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The National Science Foundation (NSF) reported 5.8% growth for 2007 in national research and development (R&D) expenditures, with industry representing the largest segment of R&D at 72% (Boroush, 2008) as compared to universities (13.3%), the federal government (10.5%), and other nonprofit institutions (4.2%).

Workers in these occupations require an in-depth understanding of both the theories and principles of science, engineering, and mathematics, generally acquired through specialized postsecondary education in some field of technology (Hecker, 2005a). To meet this need, the Bush Administration supported the American Competitiveness Initiative, encouraging science, technology, engineering and mathematics (STEM) education and workforce training (The White House, 2006). Moreover, in 1993 the Advanced Technological Education (ATE) program was established and supported by the NSF for the purpose of "utilizing the resources of the Nation's two-year associate-degree-granting colleges to expand the pool of skilled technicians in strategic advanced-technology fields, to increase the productivity of the Nation's industries, and to improve the competitiveness of the United States in international trade, and for other purposes" (Mahoney, 2000, p. 7).

The American Competitiveness Initiative was significant in that it clearly linked technical education to economic competitiveness as well as identified the role community colleges can play in training a competitive workforce (Mahoney 2000). Further, this program promoted formalized collaboration between business and education in order to develop and evaluate applied technical degree programs to produce quality technicians in an expeditious manner for local employers (Zinser&Lawrenz, 2004).

Between 2000 and 2010, the U.S.Congress appropriated $413 million for ATE programs(NSF, 2000, 2001, 2002a, 2003, 2004, 2005, 2007) designedto produce qualified technicians, improve STEM curricula at secondary and postsecondary institutions, promote professional staff development, recruit students into STEM careers and create career pathways (Patton, 2008). These programs are largely located in community colleges which have historically served as transitional institutions. As such, they work to bridge secondary schools to 4-year institutions and the workplace through horizontal partnerships with business, industry and the local community (Mobley, 2001) by providing academic preparation as well as vocational education and job training (Bailey &Morest, 2006; Kasper, 2002). This paper examines thelabor market impact and the national demand for photonic and optics technicians, and is relevant to community colleges supported by the NSF/ATE program, as the certificate and degree programs implemented at community colleges are directly targeted at satisfying this industry demand.

1.1 Community and Technical Collegesin the United States

Evidence suggests approximately one-third of all high school graduates will enroll in a community college at some point during the process of their post-baccalaureate education(Kane & Rouse, 1999). Since 1973, the percentage of US workers between the ages of 30 and 59 years who completed at least some college credit hours increased from 28% to nearly 60%, whilethe numbers of those attaining sub-baccalaureate education increased across the same period from 12% to 28%(Carnevale, Strohl& Smith, 2009).In a study comparing occupational opportunities for 2-year college students to those of high school students with no postsecondary education, Lin and Vogt (1996) concluded 2-year college students enjoyed enhanced educational and job opportunities. Similarly, Grubb (2002) found that in addition to earnings benefits, a postsecondary education increased the probability of obtaining a higher status position (e.g., professional, managerial or technical) with better prospects for advancement as well as stability of employment and less time being involuntarily unemployed.

Community colleges have long enjoyed the support of the federal government, as evident in the Obama Administration's American Graduation Initiative which calls for an additional 5 million community college graduates by 2020 as well as funding to improve community college programs and facilities (The White House, 2009):

> [W]e … know that in the coming years, jobs requiring at least an associate degree are projected to grow twice as fast as jobs requiring no college experience. We will not fill those jobs – or keep those jobs on our shores – without the training offered by community colleges. (President B. Obama, The White House, 2009)

Community colleges, in general, are challenged to meet the evolving needs of a population whose demographics are often different from 4-year schools in that they are expected to provide educational opportunities at low cost in a local setting with open enrollment to a disproportionate share of nontraditional students.

In addition, these students may possess lower academic skills, experience delayed post-baccalaureate enrollment and/or increased interruption in their education, and oftenrepresent a group who may not have attended college otherwise (Alfonso, Bailey & Scott, 2005; Bailey &Morest, 2006; Clowes& Levin, 1989).

Technology programs housed in community colleges are further challenged to provide highly applied vocational programs flexible enough to meet the technology needs of a rapidly changing labor market (Bailey &Matsuzuka, 2003). To meet these market expectations, colleges have developed programs of study by integrating new skills and material into existing degree programs and courses and/or by developing non-degree, workforce preparation programs from a set of highly applied courses. Students in technology programs, then, often require a number of remedial courses before beginning the more technical ones and cansometimes find the rigor of the technical courses discouraging. Consequently, students working to achieve a post-baccalaureate education in technological fields may conclude these programsare too difficult or simply take too long and cost too much to complete (Alfonso et al., 2005).

1.2 Rationale for the Study

The unique issues related to student recruitment and preparedness make it imperative for community colleges to accurately assess and meet the educational and training expectations of business and industry as they work to prepare a variety of technicians with 2-year postsecondary training. Based on reports from the NSF Division of Science Resources Statistics in their National Patterns of R&D Resources (annual series), technicians are likely to be employed in areas emphasizing development and applied research (NSF, 2008). As this represents more than 80% of STEM R&D expenditures, a thorough understanding of employment dynamics (e.g, current and future demand) would be helpful in justifying the establishment/maintenance of related 2-year technical programs.A recent Global Market and Salary Survey (Troy, 2009) indicated the median annual salary for photonics technicians to be $62,227, and that the industry as a whole was keeping pace with inflation as salaries had increased 4%, with job satisfaction among respondents at 75%. However, the survey was global in nature, and information was not provided regarding the sample characteristics or potential for self-selection bias. Consequently, the sample may not have been representative of the population of photonics workers.

A survey of photonics employers (n = 71) conducted by Hull and Navarra (2004) revealed an average annual demand for more than 1,800 photonics technicians. However, the study was limited by its sample size and relied heavily on email communication with employers. Identifying demand based upon a probe of industry provides considerably more accurate information than surveys of job incumbents because business and industry tend to better understand demand trends related to their own products and services for future estimation. In addition, by probing employers as opposed to job incumbants, findings may possess a lower level of response bias as employers are more likely to report accurate salaries. The present study differs from Hull and Navarra in that it relies on a larger sample of employers as well as the use of telephone surveys. In addition, in that the population of photonics technicians is structured within a hierarchical framework where technicians are nested within firms, stratification of the sample results by firm size makes it possible to sample at the firm level only and still obtain accurate estimates.Consequently, findings from the present study may better determine the ability of community colleges to meet industry demands for 2-year college photonics graduates in ATE.

2. *Methodology*

2.1 Survey and Respondents

The Photonics Technician Demand survey was designed as a sample-based survey intended to include or represent all publicly and/or privately held companies in the Photonics Business/Industrial sector. The survey was completed by representatives at manufacturing and nonmanufacturing companies known to conduct business in Optics/Lasers/Photonics. A company or firm was defined as one or more establishments under common ownership or control. When possible, prior to data collection unique firms were determined by interviewers or researchers responsible for selecting the sample, i.e. we did not contact multiple locations/offices from the same firm. In the event 2 or more representatives from a single entity were available from different locations, the best representative available at the head or main office was contacted. Key variables included in the survey were: (a) company size, (b) primary job function for technicians (e.g., R&D, sales, repair/installation, production/fabrication), (c) demographics regarding race/ethnicity andsex, (d) technician salaries at time of data collection (i.e., full compensation),

(e) current demand: number of photonics technicians employed and number of positions not filled at the time of data collection, (f) future need: number of technicians required 1 and 5 years from time of data collection, and (g) educational requirementsfor technicians.

2.2 Data Collection

Data was collected in December 2008 and January 2009. This time period happened to coincide with an 18-month recession that began in December 2007, the longest of any recession since World War II (National Bureau of Economic Research, 2010). While the data collection occurred during this period, there was no intention to collect the data in coincidence with this recession.

2.3 Sampling Frame

The target population consisted of all industrial companies that perform R&D with Optics/Lasers/Photonics technology in the United States or Original Equipment Manufacturers (OEMs) for companies performing R&D in photonics. Several lists were provided by a national center with contact information compiled over time.The *Photonics Industry Guide*(Laurin, 2008) was used to obtain information and telephone numbers for individuals within firms thought to be the best possible contact for either responding to the survey or for identifying others within the firm as being a more appropriate respondent. After files were combined and trimmed of duplicate entries, the final sampling frame consisted of 3,989 unique firms with paid employees which were then considered the target population of firms where photonics technicians were most likely to find employment. A simple random sample for the present study was drawn without replacement to generate a list of firms for contact. We continued to contact firms from this list to achieve a sample of n = 300 that either currently employed technicians or had an intention to employ technicians within the year, resulting in a total sample of cooperative firms (n = 663) that employ technicians (or intended to employ technicians) combined with those that did not employ technicians.

In order to achieve the desired cooperative sample of technician employers/future employers for analysis (n = 300), most of the sample frame records were attempted for contact (86.2% of the 3,989). A substantial number of firms (n = 987) were classified as “uncooperative/refused.” Another substantial portion of contacts (n = 1,073) were classified as “pending/not completed,” and the remaining firms were ineligible due to a variety of reasons (e.g., contact information consisted ofincorrectphone numbers, cell phone lines, orFAX lines; line was busy when called, etc.).The cooperation rate, calculated by using an adaptation of the American Association of Public Opinion Research (AAPOR, 2008) standard definition for household surveys (COOP4 = [completed interview + partial interview] / [refusals + completed interviews + partial interviews]), was 43.1%.Similarly, the response rate was estimated at 25.8%, using RR4 = (completed interviews + partial interviews) / ((completed interviews + partial interviews) + (refusals + non-contacts + other) + e (unknown organizations + unknown other)) (AAPOR),where e is an estimate of the proportion of ineligible organizations among the 1,073 records that were either unfulfilled scheduled callbacks or were never answered. Based on the findings that 1,646 of 3,475 records were not eligible, e was estimated to be 47.4 % (e = 1,646/3,475). Response rates for studies of organizations are characteristically low(Baruch &Holtom, 2008).

Data was collected via telephone across a period of approximately one month; a short data collection period was employed so that a similar time-frame was considered by all respondents. All interviews included 2 initial questions that qualified respondents for completing the remainder of the survey: (1) “Do you currently have photonics or photonics-related technicians in your company?,” and (2) “In the next five years, do you anticipate a need in your company for photonics or photonics-related technicians?”

If the response to both questions cited above was “no,” the survey with that respondent was terminated. As described above, 363 respondents in the sample resulted in dispositions for the remainder of the survey on the basis of these two questions. These respondents were considered cooperative and included as part of the sample in order to represent the number of firms within the industry that did not employ photonics technicians.

2.3 Sampling Strata

Partitioning the sample within strata prevented the large number of smaller firms from weighting the results. Proportionate stratified sampling almost always leads to an increase in survey precision relative to a design with no stratification(Kalton, 1983).

We established class intervals from the distribution with proportions that represent the population of firms in the industry as these proportions are used as stratification weights along with the population size (*n* = 3,475) to scale sample statistics topopulation estimates. Using firm size information from 294 of the 300 firms that completed the entire survey, cut points were determined for 5 proportional class intervals, each designed to contain 20% of the firms from the sample. In that the cut point values contained several firms with the same number of employees and in that the frequency of firms within a cut point was different, the strata did not contain the same frequency of firms. The goal, however, was to include an average of 58.8 firms (294/5) in each stratum. The 363 firms that responded "no" to both questions above were distributed to the 5 strata following the same distribution as the sample firm sizes as shown in Table 1.

Table 1.Frequency distribution in the stratified sample and 95% confidence interval margin of error by stratum.

Firm Size Estimate Class Interval	Sampling Frame Frequency (valid percent)	Sample Frequency	Sample Percent	Sample Valid Percent	Margin of Error
1 – 5	468 (18.5)	52	7.9%	17.7%	12.83
6 – 10	421 (16.7)	72	11.0%	24.5%	10.53
11 – 20	398 (15.8)	60	9.1%	20.4%	11.67
21 – 50	596 (23.6)	52	7.9%	17.7%	12.99
> 50	642 (25.4)	58	8.8%	19.7%	12.28
Unknown	1,464	363	55.3%		
Total	3,989	663*			3.48%

* 6 cases contained system missing values for firm size.

Two sources of firm size were used to generate a final estimate of proportional strata: (a) data was provided on 57.8% of firms in the original datasetused to establish the sampling framefor the present study, and (b) firms that employed technicians or intended to employ themin the future, when surveyed, were asked to provide information on the number ofemployees in the firm. This informationwas only collected on the firms that completed the entire survey. As theinformation was received directly from the firms, it was considered to be more accurate, and researchers assumed the population followed the sampling distribution of firm size from (b). Two cautions should be used when interpreting data in the extreme ends of the sampling distribution. First, firms that employ fewer employees may represent a portion of the population that is unstable with respect to current or projected employment of technicians. Second, firms that employ very large numbers of employees may create outliers within the sample that distort the mean, resulting in positive skew, thus potentially overstating the true demand.

2.4 Data Collection and Interviews

Trained interviewers made multiple attempts to contact companies using prepared scripts to collect information on the key variables until the desired number of interviews were completed. The specific definitions of photonics, technician, photonics technician, photonics-related technician were provided to the respondent in order to establish a common basis among all responses. The definitions were stated as follows:

Photonics: A technology which encompasses knowledge in the generation, manipulation, transport, detection, and use of light energy and information, where light refers to electromagnetic radiation extending from the far infrared region to the X-ray region. Technician: Generally defined as a person engaged in work requiring knowledge of physical, life, engineering, and mathematical sciences in support of scientists and engineers and one who has applicable knowledge acquired through technical institutes, community colleges, other formal post-high school training, or equivalent on-the-job training or experience. Photonics technician: For the purposes of this survey, the term "photonics technician" should be interpreted very broadly to include, for example, any technician who completes a two-year

AAS degree in what has been called laser or electro-optics technology. In addition, any technician who uses photonics as defined above, regardless of job title, would be considered a"photonics technician."

Photonics-related technician: A technician in other disciplines, such as electronics orsemiconductors, who uses photonics in the course of his/her work.

3. Results

3.1 Current Photonics Technician Workers

Sample respondents indicated they currently employ 3,288photonics technicians ($\bar{x} = 4.96$per firm, SD = 42.23; *n* = 663). Using the stratified sample estimates the number of photonics technicians currently employed in the U.S. is 19,785 (margin of error (*ME*) = +/- 3.6%).This estimate is based on the untenable assumption that the database used to establish the sampling frame(Laurin, 2008) includes all photonics firms in the U.S. The overwhelming majority of technicians work in large firms (> 50 employees). More than twice as many technicians are employed in this firm size category than in the other four combined. Only one firm in the sample anticipated a decrease in technician employment. This single firm projected a decrease of two technician positions at one year and that it would remain decreased by two positions in five years.

3.2 One-Year Demand for Photonics Technicians

In firms with 6-10 employees the future demand for technicians is expected to grow the most, although large firms will continue to outpace real employment levels of technicians by a very large margin and the growth of technician jobs in larger firms is also consistent with that in the category of firms with 6-10 employees. The number of new technicians required by the sample during 2009 is 269 ($\bar{x} = 0.55$technicians per firm, SD = 1.39; *n* = 483). This positive average demand should have resulted in the industry requiring 2,194 new technicians in 2009 (*ME* = +/- 4.1%). The total photonics technician workforce one year from the time of the survey was estimated from the base rate of 19,785 + 2,194 = 21,979. Throughout the entire sample, there were no firms that reported a decrease in the demand for technicians in the coming year.

3.3 Five-Year Demand for Photonics Technicians

The 2009 demand was higher relative to the five year projection. Sample respondents reported a need for 739 new technicians by the year 2014 ($\bar{x} = 1.49$, SD = 5.55; *n* = 497). The estimated average nationwide demand for new photonics technicians in five years was 5,904 (*ME* = +/- 4.1%; $\bar{x}$ =3989) (see Table 2), resulting in an average annual demand for more than 1,000 new technician positions per year. The estimated number of technicians in the photonics industry in 2014 is estimated from the base rate of 19,785 + 5,904 = 25,689.

Table 2.Average demand for new technicians based on sample data.

Firm Size Class Interval	Currently employed $\bar{x}$ (SD; *n*)	1-year demand $\bar{x}$ (SD; *n*)	5-year demand $\bar{x}$ (SD; *n*)
1-5	0.65 (1.12; 94)	0.53 (1.02; 92)	1.36 (3.41; 91)
6-10	1.36 (2.10; 146)	0.68 (1.60; 125)	1.55 (3.75; 125)
11-20	2.38 (5.84; 122)	0.48 (1.15; 94)	1.36 (3.35; 96)
21-50	3.15 (6.29; 110)	0.39 (1.22; 82)	1.38 (3.52; 84)
> 50	17.30 (93.62; 117)	0.60 (1.76; 90)	1.71 (10.80; 86)
Total Sample	4.96 (42.23; 589)	0.55 (1.40; 483)	1.48 (5.56; 482)

These future estimates include new positions only, and do not consider demand for photonics technicians that might result from replacement of existing workers that leave the workforce in the coming years (e.g. retirement, morbidity, or departing the industry). Examining 1-year and 5-year projections in Table 2, firms within the class intervals 6-10 and > 50 are more confident about the future employment opportunities for technicians than firms in other categories. The projected number of technicians required by the industry over the ensuing five years was estimated to be 25,689.

3.4 Positions Unfilled

The demand data is contrasted by photonics technician positions currently unfilled. Reports of unfilled positions are perhaps the most conservative estimate of existing demand. At the time the survey was conducted, firms (*n* = 195) reported that on average, 0.46 (SD = 1.33) photonics technician positions are currently unfilled.

The current industry demand based on unfilled positions was 1,835, representing 84% of the 2010 demand. Therefore, commitments existed for the vast majority of positions reported to be needed in the coming year, with only 16% of the 2,194 positions remaining to be opened.

3.5 Job Functions

Since community colleges must prepare technicians to work in the types of jobs available, we asked employers to categorize the positions they sought to fill into four categories: R&D, Sales, Service/Repair, or Production/Manufacturing.Within the photonics industry over 39% of technician jobs are in production/manufacturing, more than 30% in R&D, approximately 18% in service/repair and over 12% in sales.

3.6 Educational Requirements

Respondents were asked two questions about the education of photonics technicians. First, what the existing educational background was for technicians currently employed, and then asked what the preferred educational background would be for technicians. Respondents reported on the educational level obtained by 453 technicians. The current level of education of photonics technicians in the industry was reported as: 2% no high school diploma, 18% high school diploma, 29% two-year college, 38% four-year baccalaureate degree, and 13% apprentice. When inquired about the desired level of education or training needed for photonics technicians, employers would prefer that technicians obtain a two-year education, and that the current practice of employing baccalaureate degreed technicians is not necessary in many instances. The respondents reported the following preferred education level for photonics technicians: 5% no high school diploma, 9% high school diploma, 47% two-year college, 30% four-year baccalaureate, and 9% apprentice.

3.7 Technician Earnings

Respondents (n = 192) revealed information about the annual earnings of entry-level photonics technicians at their firm. The average annual earnings of entry-level technicians are $39,082 (SD = $13,320) with a median rate of $37,720 ($Q_1$: $30,000, Q_3: $45,000). Firm sizes were examined with one-way ANOVA for differences between means. No significant differences in pay were detected based on firm size ($F_{(4,\ 187)} = .415$, $p > .05$), therefore technicians can expect similar pay regardless of firm size. This is an indication of robust demand for technicians since they command similar pay regardless of the firm size sector where they work. Given that the majority of technicians possess less than a 4-year baccalaureate degree, the earnings available are equivalent or greater than many occupations where a 4-year degree is required.

3.8 Sex

Females represented 14% of all employed photonics technicians. The findings are consistent with women participation in careers related to physics, astronomy and engineering where participation rates are close to 10% (NSF, 2002b).

3.9 Ethnicity

The NSF (2002b) reported that Asians, blacks, Hispanics, and American Indians represented 18 percent of the science and engineering workforce in the United States in 1999. In contrast, it was found that approximately 10% more of the photonics technician workforce was composed of minorities (9.9% Hispanic, 4.9% Black/African American, 9.4% Asian, and 4.5% other). Of particular interest is the number of Hispanic workers. The NSF reported that only 3% of science and engineering workers were of Hispanic origin, yet in the photonics technician workforce the make up the largest minority percentage, surpassing even Asian minorities.

4. Discussion

The purpose of the present study was to provide an estimate of the number of photonics technicians employed in the United States and to determine current and future demand for photonics and optics technicians. Moreover, we sought to characterize the existing technician workforce by sex, ethnicity, and earnings. We know of no prior studies (other than our own) that have attempted to estimate the demand and characteristics of technicians, and given the emphasis placed on education and training of technicians by the National Science Foundation (though congressional mandate) and the efforts of community and technical colleges to educate such technicians, an estimate of demand is important to justify some relatively large financial and personnel commitments to prepare these workers. The information presented here indicates that more emphasis may be required.

4.1 Current Demand for Photonics Technicians

The conservative estimate of nearly 20,000 employed technicians indicates photonics technicians represent an important component of the American STEM workforce. Certainly there are a large number of positions currently filled in this high technology sector that do not require the same skills of engineers or scientists. Educational programs should emphasize skill areas that prepare technicians for production, fabrication and manufacturing as well as positions in R&D as these types of positions require higher technical skill levels than sales or service/repair positions. By preparing technicians with higher-level skill abilities, educational institutions can service all four job function areas. High levels of R&D and production/manufacturing are indicative of an industry that is very healthy and growing since new R&D produces new products and the higher levels of production indicate demand for existing products and services (Berman, 2005).

Desired reductions by the industry in the proportion of technicians with 4-year baccalaureate degrees and those with apprenticeships indicate the industry is hiring technicians regardless of their educational preparation and in some cases are training them internally (i.e., apprentices). The overwhelming preference of employers appears to be to hire technicians from 2-year degree programs. It appears a small proportion of positions would be better filled with non-high school graduates, but, in general, a 2-year degree is recognized as the credential of preference for most technicians. More work is required that examines these skills.

4.2 Future Demand for Photonics Technicians

At a time when unemployment nationwide in the United States had increased more than 4% within a 9-month period, photonics firms estimated that nearly 2,000 technicians were needed in the next year, more than 10% of the current photonics technician workforce. The U.S. unemployment rate increased from 5% in April, 2008, to 8.9% in April, 2009 (BLS, 2009b), resulting in more than 5.7 million jobs lost. This survey, conducted in January, 2009,when unemployment was increasing, suggests that this industry, and technician jobs are resistant to global economic forces and maintains a large number of positions available for qualified job seekers. However, the requirements for employment in this sector as a technician appear to beincreasing. More firms desire employees with advanced technical skill offered by 2-year degree programs.Two-year degree programs are, therefore, challenged with remaining current with technological advancements as well as producing graduates who are critical thinkers, active listeners and lifelong learners (Weeks, 2009; Torraco, 2008).Nearly half of respondents in this study indicated a preference for hiring photonics technicians with a 2-year associate degree, while only 30% indicated a preference for hiring photonics technicians with a bachelors degree and only 9% preferred hiring photonics technicians with a only high school degree.Simultaneously, the manufacturing sector lost more than 2.9 million jobs by September, 2008, and construction employment had declined at a rate of 120,000 per month across the 6 months prior to data collection, almost 3 times the rate since the beginning of the 2008 recession (BLS, 2009b).

4.3 Earnings Potential of Photonics Technicians

Wages for technicians appear to be high, with the average annual earnings for entry-level photonics technicians estimated at $39,082. While considerably less than that reported by a salary survey of the entire photonics field (Troy, 2009), or wages provided for technicians in similar fields (BLS, 2009b), the wages reported here for entry-level positions appears to be quite high.For comparison, at the time of data collection, public school teachers earned a median annual salary of $28,660, including experienced and inexperienced teachers, and this field requires a bachelor’s degree for employment.

4.4 Implications for Education and Training of Photonics Technicians

The logical conclusion is that 2-year degree programs should be flooded with applications from unemployed individuals seeking high-wage job opportunities.Based on information from our colleagues at two-year institutions, we fear this is not the case.Squires and Case (2007) write of the critical need to increase high school student recruitment efforts into technical programs.And we have demonstrated the possibility of a gap between industry demand and two-year college supply.

4.5 Future Research

Given this potential gap, questions remain regarding differences in primarycognitive abilities and interestsamong technicians and/or engineers or physicists, and how these individual differences may be deterring individuals from seeking careers as technicians in high demand fields.

Many students who struggle with traditional coursework might flourish with hands-on learning (Jacobs, 2001). Do technicians possess spatial skills similar to or perhaps greater than those of the engineers or physicists who work alongside them? Do they have different personality types? How do proclivities toward the workplace (e.g., cognitive ability and personality) tend to be evidenced in the unique skill sets required of technicians?

5.0 Conclusion

We have demonstrated that a considerable need exists for the education and training of technicians in the field of optics and photonics technology. Employment opportunities are available for females and minorities, and entry-level salaries are quite high. The findings of the present study suggest that the National Science Foundation's Advanced Technological Education program is well targeted, but having less impact than it ought to with respect to supporting U.S. technological firms in filling available technician positions with qualified workers. More attention is needed on the engagement of additional students in community college training programs, as it appears the NSF and Colleges have implemented programs, but a considerable gap exists for employers to fill with qualified technician workers.

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