CATCHING UP WITH THE TECHNOLOGICAL PROGRESS
IN THE SURVEYING AND MAPPING WORKPLACE
BY INTENSIFYING SCHOOL-INDUSTRY PARTNERSHIPS

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Abstract

The surveying and mapping workplace experiences rapid changes of technology, with the emergence of electronic total station (ETS) and global positioning system (GPS) triggered by electronic and digital technologies. This has caused vocational secondary schools find difficulties in catching up with such progresses. Purchasing new equipments being out of date after a few years is too expensive for schools, so it needs other alternatives to overcome this challenge. Based on the effectiveness and efficiency reasons, industries tend to be more advance in technology updating, leaving vocational schools behind. Intensifying partnerships between school and industry can meet this challenge of technological progresses.

Currently school-industry partnerships are usually limited to two typical activities, industrial work practice or internship and competency test. There are really various activities could be proposed by such partnerships, covering the student learning processes, apprenticeships for after-graduated, and externships for enhancing teachers’ competencies. The activities on the students’ learning can be guest speakers from industry, industry visits by students, industrial practice orientations involving practitioners, and demonstrations of up-to-date equipments by industry. Such partnership activities can only succeed if there are mutual benefits for school and industry. The industry benefits from the availability of competent workers and the school’s main benefit is the more relevant learning program to meet the requirements of the world of work.

Keywords: changes of technology, vocational education, surveying and mapping, school-industry partnerships.

1. Introduction

The surveying and mapping workplace experiences rapid changes of technology, with the emergence of electronic total station (ETS) and global positioning system (GPS) triggered by electronic and digital technologies. This has caused vocational secondary schools preparing workforces for this field find difficulties in catching up with such progresses. Purchasing new equipments being out of date after a few years is too expensive for schools, so it needs other alternatives to overcome this challenge.

Surveying and mapping works are needed for all infrastructure planning and construction. These works are conducted by at least three levels of workers, namely engineer, technician, and operator. There is a lack of workforce of the operator level, although there have been 47 vocational secondary schools (VSSs) running the surveying and mapping program all over Indonesia. This could be caused by a gap between the school graduate competencies and the requirements of the surveying and mapping industries. The lack of up-to-date equipments to some extent contributes to this gap. Based on the effectiveness and efficiency reasons, industries tend to be more advance in technology updating, leaving vocational schools behind. To bridge this gap, learning applied by the surveying and mapping program should be developed responsive to the needs of the world of work.

The surveying and mapping program of the VSSs is designed to produce surveying and mapping workers at the operator level. The surveying and mapping or geomatics expertise group of the national vocational education chamber has set geomatics competency standard including competency standard of surveying sector for the operator level. Based on this standard, the Ministry of Workforce has produced a regulation of the Indonesian National Work Competency Standard for Consultancy Industry Service sector, Surveying and Mapping subsector. To achieve this standard, the Ministry of National Education has established the competency standard and basic competency to be applied in the learning process of the VSSs including the surveying and mapping program. To support this program, electronic school books including the surveying and mapping field have actually been published. The learning process in the schools, however, still faces many difficulties to provide graduates meeting the requirements of the world of work. The learning outcomes have not adequately responded those needs.

Learning responsive to the needs of the world of work could be achieved by involvement of the industry in the students learning processes. The world of work of surveying and mapping may be in governmental or private institutions. Governmental
institutions which need surveying and mapping works are such as institutions managing public work, land administration, land and building taxes, mining, agriculture, forestry, and defense. Such institutions generally order relatively larger work volumes to private companies, so there are only small numbers of permanent workers needed. Private companies of surveying and mapping also rarely have large number of permanent workers, because many workers are recruited from free lance workers when they get work orders. Relatively high worker mobility leads to a constraint for involvement of surveying and mapping of work in the learning process. Most of surveying and mapping workers, of engineer, technician, or operator levels, are not tightened to particular companies. They are recruited by companies getting surveying and mapping jobs. Another problem is relatively long distances from schools to the world of work. Moreover, the distances from the offices, governmental or private, to the work sites may or even often too far, on different provinces or even different islands.

2. Technological Progresses in the Surveying and Mapping Workplace

Accelerated technological progresses make it more essential for education institutions to respond the ever-changing needs of the world of work. The land surveying and mapping works are conducted using surveying equipments that can be optical or electronic. The technological progress of the surveying equipments tends to be more electronic or digital. The digital surveying equipments include: Electronic Distance Measurement (EDM), Electronic Total Station (ETS), digital theodolite and digital level. Digital surveying instruments benefit such as quicker operation and less human errors such as estimating and reading errors.

Since the development of computer technology, in surveying and mapping activities the terms “geoinformatics” and “geomatics” emerge. Both terms are used in the developed countries such as America, Europe, and Australia, since the 1990s. Data acquisition techniques are developed from terrestrial surveying to remote sensing by utilization of aircraft and spacecraft platforms. The positioning technique is developed from optical, optical-electronic, electronic, and finally digital, from land-based measurement to space-based measurement such as Global Positioning System (GPS) satellites. The knowledge of geomatics consists of not only data acquisition, but also geographic (spatial) information system development and spatial data modeling to develop decision support system for various planning works. There is a shift on human resource education from surveying techniques to geomatics techniques. Geomatics profession previously named surveyor or land surveyor or mapping surveyor changes to geomatics surveyor.

Surveying and mapping works can be divided into three steps: data collection step, data and information processing step, and data and information presentation. Technological development in the data acquisition step is marked by more widely used electronic and digital instruments, and satellite technologies for positioning and digitally recording earth surface images. In terrestrial surveys, conventional (optical) instruments such as theodolite and level shift to electronic such as digital theodolite, digital level, and electronic total station (Figure 1). Extra-terrestrial surveys using satellites such as GPS are more widely used with higher accuracy especially for horizontal position (Figure 2). Remote sensing with higher resolution replaces terrestrial and photogrammetric detail surveying.

Figure 1. Surveying using Electronic Total Station (courtesy of CV Putra Mandiri)

Figure 2. Surveying using GPS (courtesy of CV Putra Mandiri)
In the competency standard and basic competency applied for the surveying and mapping program in the VSSs, there is no explicit content of the newest technologies to respond the technological progress, except for GPS. The more developed countries, such as Australia and the United States of America, on the other hand, explicitly address this progress in their curriculum. In Australia [1], the uses of newest technologies are explicitly accommodated in the curriculum of surveying and mapping education and training programs. In the Certificate program (475 hours) about 40% of the whole time allocation, the modules or units referred to technological development are explicitly included in the curriculum: Perform basic spatial computations (100 hours), Operate computer packages (25 hours), Develop and use complex spreadsheet (30 hours), and Prepare and present Geographic Information Systems Data (36 hours). In the Diploma program (1400 hours), the modules/units explicitly referred to technological development are placed about 32% of the time allocation: Perform advanced GPS data collection (40 hours), Manage advance surveying computation (80 hours), Develop complex spreadsheet (30 hours), Design spatial data storage systems (60 hours), Present GIS data (36 hours), Data analysis with GIS (36 hours), and Develop two-dimension and three-dimension terrain visualization (160 hours). In the United States, the curriculum of the Surveying and Mapping Technology program [2] also lists explicitly the newest technologies: Conduct electronic distance measurement, Use GPS, and Conduct Computer Assisted Drafting (CAD) drawing.

The problem of keeping pace with technological advance does not only take place in the developing countries, but also in the more advanced ones. Maintaining the currency of knowledge and equipment within public technical institutions in the United States, Germany and Australia appears to be common difficulties [3]. Maintaining up-to-date equipments is very costly and they become quickly redundant. Every three to five years, the equipment becomes obsolete as new technology emerges, so the equipment needs to be replaced [4].

The more advanced technologies promise more effective and more efficient works. Therefore based on the effectiveness and efficiency reasons, industries tend to be more advance in technology upgrading, leaving vocational schools behind. The schools therefore need to approach to industries for sharing their resources. This can be attempted only by a closer relationship between school and industries, therefore more learning activities can be implemented. Intensifying partnerships between school and industry may meet this challenge of technological progresses.

3. Current School-Industry Partnership

Currently, the students learning processes in the vocational secondary schools conducted by the involvement of the world of work or based on school-industry partnerships are generally limited to two typical activities, the Industrial Work Practice (IWP) and competency test. Both IWP and competency test are only once experienced by students during their study in the VSS (Figure 3). In IWP, students learn in the world of work guided by the practitioners of the industry and the guiding teachers. IWP usually lasts for three months, while the industries usually require six months if they are asked to contribute in funding the activities. In the competency test, industry practitioners act as one of the assessors as external testers. As the nature of surveying and mapping industries, the participating world of work could be governmental or private institutions. The governmental institution that participates most is the National Land Agency, because of its relatively well geographic distribution, exists in every district/city. However, the competencies which can be learned there are very limited, they have not covered all competencies set in the competency standard and basic competency. IWP in a private company faces problem whether such company gets a job order or not. Moreover, the characteristic of the job is temporary, not well distributed along the year, and it is not always matched with the school schedule.

One problem of the involvement of the world of work in student learning is the industries tend to get ready-to-work graduates only, so they will not need to train them. Even students who are going to have IWP are required to be ready-to-work also. In fact, students often meet equipments they have not learned before, so they are considered as not competence by industry practitioners. The students therefore need an early orientation to the world of work before they have IWP. Another problem is the locations of the world of work that are often in long distances from the school. In order to be able to establish learning that is responsive to the needs of the world of work, those problems need to be solved, so the involvement of the world of work in learning can be conducted.

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<tr>
<th>VSS</th>
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<td>Industrial Practice</td>
<td>Competence Test</td>
<td>Surveying and Mapping World of Work</td>
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Figure 3. Current Partnership of Students Learning
4. Activities of School-Industry Partnerships

School-industry partnerships give various opportunities to improve the students learning processes. Various identified activities [5] could be implemented in vocational education and industry cooperation: career day, school advisory committee, job analysis by teachers, personal contact to persons from the world of work, cooperative work experience program, vocational training for teachers by holiday session work, school program publication and information for the world of work, partnership of teachers and the world of work, students’ productive activities sponsored by industries for educational purposes, industry persons as source persons (consultant, speaker) in school, survey of the world of work by teachers, such as: job, equipments, and needs assessment survey, teachers act as consultants of the world of work, such as in worker training, work system and procedure, the world of work sponsors learning materials, equipments of the world of work displayed in school, and continuing education program, such as short course, workshop, training or retraining for workers or worker-candidates.

The role of the world of work in school advisory committee is very important [6]. The school advisory committee may consist of the world of work, union, local government, public service agency, and graduate user elements. The cooperation links between school and the world of work are important and teachers should have self-confidence and be admired by their related people of the world of work. Therefore, teachers should periodically renew their skills, learn new practices, and keep in touch with the world of work. Various identified roles of the world of work are such as: introduce students to the real work situation, workers as temporary instructors in school, training in the workplace, link theories and the real practices, feedback from the world of work for education programs to revise and improve the programs, apprenticeships, dual system education, and graduate placement [6].

Considering the very essential roles of the world of work, developing closer partnerships between schools and the world of work is absolutely needed. From the above description it could be concluded that the success of the education program in VSSs is very determined by the partnerships between school and the world of work. By this partnership, schools can respond the needs of the world of work by developing learning practices relevant to those needs.

Although other than the surveying and mapping field, many researches of the partnerships between schools and businesses have been reported, such as the mutual benefits when information technology (IT) companies partner with high schools [8], i.e. the students get the necessary career training for future success and the companies get a skilled workforce for the future. The partnerships between high schools and private high-tech companies prove to be one way to ensure that students learn skills relevant to current workplace. Three examples of high school-company partnerships working together to train future technical workforce are concluded: a local entrepreneur helps students gain skills and serve community, a training company teaches students marketable skills, and a local training company puts faith in high school students.

Another report observing the automotive industries highlights the need of partnership of schools and industries to keep up the flood of new technology [9]. This quick technological change may swamp both schools and businesses if they do not work together to prepare technicians for the new world of auto service and repair. The listed barriers of updating technology in schools, i.e. the limited schools’ budget to purchase new equipments, the instructors’ lack of training needed to have industry’s credibility, and the lack of administrators’ and guidance counselors’ recognition to the needs of updated skills. Based on the survey of four automotive technology programs, a high school, a vocational center, a secondary-postsecondary vocational-technical center, and community college, the listed ways to overcome the obstacles, i.e.: (1) rapid technology advances require students master not only specific technical skills but also the academic and thinking skills for continuous learning, (2) a program cannot survive merely on money from the district or institution, so instructors must be creative in finding funding or donations, (3) instructors must establish partnerships with industries to keep current with needs, provide on-the-job experience for students and gain access to resources, (4) to get funding from public and corporate sources, a program must prove itself, beginning with certification for instructors and certification for such program, and (5) because schools need up-to-date equipments and the industries need good training programs for future and current technicians, the two should share resources.

Vocational teachers may use external and internal sources to keep up new technologies [3]. The most commonly used and important external sources are leading-edge private users or producers/suppliers of advanced technology, industry associations, and time spent with the learners themselves and in plants. The most commonly cited and important internal sources are websites and journal circulation. Sharing information and networking with other colleges and undertaking professional development are also important.

Regarding the partnership between schools and industries, various activities are listed [7], such as participating companies as advisory board
members, helping schools to develop internships within their firms and others, planning events and activities for students, providing direct financial assistance, securing financial assistance, providing advice on curriculum and program design, and serving as an advocate of the program to the school district. Furthermore the majority of industries also provide other learning experiences for students, including mentoring, workplace tours and job shadowing.

The partnerships of schools and industries obviously benefit schools [7], such as the employers provide funding for program administration, a student conference, overnight job shadowing and an auction, the employer partners review the curriculum annually, provide internships and offer mock interviews for students to practice their skills. Such employer involvement impacts teachers’ work. Approximately half the teachers surveyed had participated in formal employer-sponsored professional development, such as job shadowing, having an internship, or consulting with employers on course content. An employer-teacher mentorship program was initiated, in order to facilitate communication between school staff and the business world. This allowed teachers, many of whom have no business experience, to bridge the gap between school and the business world. Students also benefited from employer involvement, beyond their workplace learning experiences. The employers serve as a source of adult support and as role models. Most students who had paid summer internships through the academy program said that they had discussed possible careers with their employer. They also agreed that someone in the business took an interest in them. Over half said that their academy summer internship or an academy mentor were significant influences in their future career direction. Finally, and perhaps most significantly, 40% of the alumni surveyed said that, the fall after high school graduation, they held a job with a NAF-affiliated employer.

How such partnerships benefit the industries is also proven [7]. The employers have both philanthropic and individual reasons for participating. Their most important motivation for participating tends to the philanthropic response, i.e. contributing to education and the local community. The second most frequent reason is increasing organization’s positive image in the community. The other less stated reasons are encouragement from other employers, shortage of employees, networking with other firms and building a client base.

5. Intensifying School-Industry Partnership

There are really various activities based on school-industry partnerships could be implemented, covering the student learning processes, apprenticeships for after-graduated, and externships for enhancing teachers’ competencies. The activities on the students’ learning can be guest speakers from industry, industry visits by students, industrial practice orientations involving practitioners, and demonstrations of up-to-date equipments by industry. Industry practitioners as guest speakers may give the students an overview of the world of work especially current technologies and equipments applied there. Students visit to industry provides a great opportunity for them to explore what is really going there, especially the emerging technologies applied in the world of work. Industrial work practice orientation by industry practitioners can equip the students with the more current knowledge directly informed by industry persons. Demonstration of up-to-date equipments by industry practitioners could minimize the strange feeling of students toward new technologies.

The students learning processes involving the world of work to provide students familiar with new technologies will not succeed unless being supported by the teacher’s experience in the real world of work. The teachers themselves should have sufficient experience with such up-to-date technologies. A program called externship is needed to equip teachers with such experience. By externship program, the teachers gain industrial experiences by working in industry for a certain period of time.

Although many activities have been conducted during their study in VSS, due to the dynamic nature of the world of work, the graduated students may need to supplement and enrich their experiences by an apprenticeship program after their graduation. Those various students learning activities, supplemented by after-graduation apprenticeship program, hopefully will make the process of providing new workforces entering the world of work with ever-changing technologies smoother.

Such partnership activities described above can only succeed if there are mutual benefits for school and industry. The industry can get the benefits mainly from the availability of competent workers therefore it will minimize the training cost of the new employees. The school’s main benefit is the more relevant learning program to meet the requirements of the world of work.

The two typical activities of students learning processes involving the world of work are the Industrial Work Practice (IWP) and competency test. IWP is usually conducted at the fourth semester and the competency test at the final semester. Therefore, the students currently get learning processes with the involvement of the world of work only at two, of their six semesters. As a result there are still four semesters students have learning processes without the involvement of
the world of work. As an alternative to optimize learning by intensifying school-industry partnerships, some learning forms could be developed, such as: (1) practitioners as guest teachers from the world of work visit the schools to teach students, could be conducted at semester one, (2) students learn by visiting the world the work, could be at semester two, (3) practitioners from the world of work deliver IWP orientation, could be at semester three, and (4) instructors from the world of work bring and demonstrate up-to-date equipments to students, could be at semester five (Figure 4). An illustration of the documented photographs of the surveying and mapping VSS students visit to the world of work is displayed on Figure 5.

Considering the various sectors of industries employing surveying and mapping workers, the industries involved in the students learning could be assigned varied, from different sectors for different activities, such as land administration, public work, mining, agro-forestry, and defense. Besides leading to get more familiar with up-to-date equipments, learning with the involvement of the world of work hopefully lead to student achievement of competencies currently less mastered, such as work attitude and ethic, and professional responsibility. The work attitude includes attitude towards local labors, equipments, and data of surveying and mapping. On data collecting step, there is a difference between practice in school and the real work. In school practice, a student is assisted by other students, while in the world of work a surveyor is assisted by some local labors recruited from the work site surrounding.

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Figure 4. Students Learning Activities Based on Intensified School-Industry Partnerships

Figure 5. VSS Students Visit to the World of Work (courtesy of SMKN 2 Yogyakarta)

6. Conclusion

The surveying and mapping workplace experiences rapid changes of technology, such as the emergence of electronic total station (ETS) and global positioning system (GPS) triggered by electronic and digital technologies. This has caused vocational secondary schools find difficulties in catching up with such progresses. Purchasing new equipments being out of date after a few years is too expensive for schools, so it needs other alternatives to overcome this challenge. Based on the effectiveness and efficiency reasons, industries tend to be more advance in technology updating, leaving vocational schools behind. Intensifying partnerships between school and industry can meet this challenge of technological progresses.

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ACKNOWLEDGMENT

Special thanks to everyone who facilitates and supports the writer to study in the Technology and Vocational Education Doctorate Program, Yogyakarta State University, and to participate in the Sandwich-Like Program in Ohio State University, USA, that has enriched the writer’s academic vision.

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