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Development of work based learning (WBL) learning model in heat transfer courses

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Abstract. This 4.0 industrial evolution era requires university institution to process and result its qualified graduation using 4C approach, namely; *Critical thinking, Creativity, Communication, and Collaboration*. Qualification of engineering graduation is dominantly determined by learning model applied in the class such as *Work Based Learning*. The Work Based Learning Model is a change of learning system from conventional system in the class into a system placing the education into work place, in this case is in laboratory. This system combines institutional learning pattern in classroom by real equipment in the laboratory so that it can result in integrated experiences between theories and real practices by students. Basically, WBL is a learning model approach using work place as a media to transfer learning knowledge. During student period of learning on *heat transfer* course, it only describes theoretical information description in uncritical learning process, less creative, passive communication and no inter-student collaboration. There are many various models studied by experts to identity any components having influences on making successful WBL. This article tries to identify and review the development of work based learning models that will be applied to the Department of Mechanical Engineering at Bung Hatta University.

1. Introduction

Current education system is facing changes according to demands of the 21st century development. So far, the education world only creates graduates regardless of the needs of workforce, so that many graduates from technical and vocational scholarships are not taken by workforce since graduate competencies are not in line with the world work. As a result, there are many graduates working in not well-adjusted field (Piiro, J. 2011 ; Taylor, S. 2012).

Quality of educational outcomes in the education reform era must be given attention and priority. Based on (Ministry of Education, 1996: 19) demands for the quality of education development for 2020 are based on four national basic strategies, namely; synchronization of opportunities, relevance, quality



and efficiency. It is necessary for synchronization and synergy of three elements such as government education policy, quality of undergraduate graduates produced by university and employment demands.

Data released by Putra Sampoerna Foundation cited inspiration .ir (2013), stated that engineers are the most required expert by Indonesia. Indonesia needs 175,000 engineers per year, while Indonesia can only produce 42,000 engineers. While the number of engineering students is only 11% of the total 5.3 million students in various majors.

Learning methods in general in technical education institution in Indonesia are applied in class and laboratory. In particular, *heat transfer* subject learning in Department of Mechanical Engineering Bung Hatta University is applied theoretically in class. Results in the learning process are not critical, less creative, passive communication and no inter-student collaboration. From several years of teaching experience after a thorough evaluation, it can be assumed that results of the learning process have not provided maximum benefits, so it is necessary for efforts to improve methods and new learning systems such as development of WBL in institution.

The development of learning in the implementation of technical education and vocational education must continue to be taken by its managers so that quality of graduates will be well-adjusted to the demands of job market. Education serves an important role in providing a superior workforce and having competencies in accordance with their fields so that it can be able to increase AEC activities.

Efforts to implement *Work Based Learning* in engineering education have been started in the 20th century in universities in developed countries which have long been implemented, for example, America, Europe and Australia.

In England according to Ebutt (Gray, 2001:4), he described that WBL “*as a major constituent of a program of study where student are full-time employees, and most of the research-based fieldwork is carried out in the learner’s own workplace*”. Also, Naylor (Cunningham, Dawes, & Bennett, 2004:4) said that WBL “*is apart of a three –pronged approach to school- to -work transition that also includes school-based learning and connecting activities*”.

Fink, Rokkjaer & Screy (2007:2) stated that *Work –based learning is used as terminology in USA for programs for school children to obtain experience from work and for young people to be prepared for the transition from school to work and, to learn the realities of work and be prepared to make the right choice of work...*

There are various indicators of education quality as the problem background in the implementation of Bachelor education of Mechanical Engineering at Bung Hatta University with a Work-Based Learning (WBL) approach.

The work-based Learning can be effectively used in universities with specialization of engineering and applied to Technical and Vocational Education but it is less suitable for more directed majors towards academic disciplines such as economics and business science (Stones, 1994). WBL is a form of learning that deals with all fields of work, work-based learning, workplace learning and work learning (Seagraves et al., 1996).

According to Wilson 1997, WBL is one of the learning approaches that has been practiced throughout the world for decades and meets constructivism theory, as an active and dynamic form of learning that slowly develops throughout the lifetime of an individual.

Researchers determine WBL as different one from conventional training, which it is directly involved and makes real experiences from the workplace (Seufert, 2000). In addition, acquisition of specific and competent skills in workplace allows students to improve their skills and competencies to a critical level through certain types of learning models. This is supported by Glass et al. (2002) stated that WBL is learning model in workplace and learning process taking over its role played by work place, since WBL is a learning approach using workplace as a medium for knowledge transfer. In general, the WBL method involves combination of learning models in educational institutions and workplaces. There are various models used to create successful WBL methods.

While according to Becker (2007), WBL is a learning approach that includes work experience facing by students in the learning process in an institution in order to obtain experience and apply their skills in related industries according to what is certainly required in an actual work environment. The WBL

method is the terminology used for students at school level so that they can obtain experience through work. This enables students in institutions to adapt to outside institutions so that they can work and expose students to reality of a work environment which enables them to make their possible best career options (Fleming & Martin, 2007).

Researchers determine the WBL as a different one from conventional training, which it is directly involved and makes real experiences from workplace (Seufert, 2000). In addition, acquisition of special skills and competency in workplace allows students to increase their competence to a critical level through certain types of learning models. This is supported by Glass et al. (2002) stated that WBL is learning in workplace and learning process that takes over the role played by the work place. This is because the WBL is seen as a learning approach using workplace as a medium for knowledge transfer. In general, the WBL method involves a combination of learning in educational institutions and workplaces. There are various models to make successful WBL method. Researchers have stated that WBL is a term used to describe programs by learning institutions combining universities and work organizations in order to create new learning opportunities in the workplace (Lemanski et al., 2011).

2. WBL Concept

Conceptualization of WBL does not directly conflict with the idea of discipline-based learning which forms the basis of higher education, but this indicates that there will be broader WBL scope; basically a trans-disciplinary or post-disciplinary framework that can combine disciplinary learning but also transcend it.

Work-based learning is seen as a model playing a role in improving professional development and learning. According to Fink, Rokkjaer & Schrey (Fink, Rokkjaer, & Schrey, 2007) stated:

Work-Based Learning is an approach with focuses upon the practical utility of learning and is therefore directly relevant to learners and their work environment. A WBL approach to learning acknowledges that learning can take place in variety of situations and settings, and is not restricted that developed through the classroom or lecture theatre. All WBL programs utilize a range of tools to aid and enhance guided learning activities. This 'blended' learning approach enables WBL program to be tailored to student needs and preferences, whilst still operating within an academic framework. WBL is a practical and successful way of creating university-level learning that is directly related to the workplace

Work-based learning is actualized according to an adequate or effective conception of researchers' perspective so that it can create capabilities of an idea by Lester (2004) developed by Stephenson (1998) and (O'Reilly, Cunningham & Lester, 1999). More relevant broader viewpoints to the WBL at university level can consider type and level of problems faced by practitioners and allow details of the problem for negotiation. Especially but not only at postgraduate level, WBL can be practiced by developing adequacy as called by Schon (1987) with a term of 'swamp' from real-world practice in which practitioners are involved using a mixture of uncertain problems, inappropriate pieces and people who do not behave according to the theory.

Related to any aspects of career development, the WBL components (Ugochukwu, 2013) expose students to various job settings in order to assist them in decision-making process on direction of their career and future work. The WBL focuses are also classified into cooperation, field trips, shadow jobs, field trips, entrepreneurship, internships, clinical experience and youth internships.

3. WBL Model

3.1 WBL Characteristics

David Boud (Boud & Solomon, 2003) Typically described WBL programs in many characteristics, among others: (1) existence of partnerships in educational institutions with external organizations; (2) Involvement of learners as workers (by making negotiated learning plans); (3) Formulation of learning programs from the needs of workplace and participants; (4) adaptation process of learning programs both individually for each learner according to their previous educational / work / training experience;

(5) learning programs as integrated projects / tasks in the assignment; (6) Learning outcomes as measured by educational institutions.

According to the Work-Based Learning Guide (Morley, 2010) key characteristics in the implementation of theory-based learning program are: (1) the program is coordinated by a “qualified” coordinator and one with dedication; (2) learners join the program based on clear occupational attitudes, needs, interests and goals; (3) training places in the workplace are developed by the coordinator to provide on-the-job / workplace information that is directly related to the learner’s career needs and goals; (4) the taken career guidance includes information about traditional and non-traditional occupations. Further characteristics are: (5) relevant planned instructions and directly related to learner’s OJT experience and needs; (6) the rules developed are clearly determined and actual responsibilities are measured from program guidelines / guidelines; (7) evaluation activities allow teacher coordinators to monitor programs; (8) advisory committees to balance gender / ethnic / occupational community aspects provide advice and assignments in planning, development and implementation processes; (9) written training agreements / agreements and individual learner plans are carefully developed and approved by employer / owner of the company, sponsors of training, learners and coordinators; (10) employers provide compensation and credit awards to learners for complete OJT experience; (11) WBL training location is well-adjusted to state or federal law in terms of employment practices.

It is very important that everyone in the community understands work-based learning missions. It is necessary for people to think of work-based learning as a two-way bridge between classrooms and workplaces in which schools and communities work cooperatively to provide resources and “classrooms” so that each student will be assisted to find and develop their potential.

Work-based learning can be applied at educational institutions or business units. This requires a coherent sequence of activities that prepares students to function at the highest level of work-based learning in the workplace.

According to Lynne (2003), one of the models used to implement the WBL is Arizona Work-Based Model of Learning Resources Guide. Figure 1 shows the WBL implementation model in Arizona.

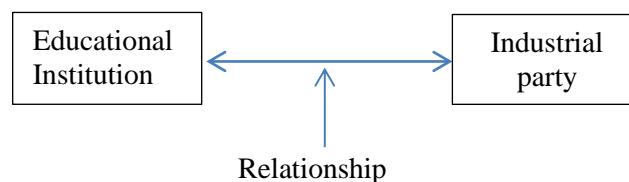


Figure 1. WBL implementation model in Arizona

Figure 1 states that WBL creates two-way relationship between education and industrial institutions through various activities and resources. Researchers have stated that a strong two-way relationship can create more effective and efficient WBL method (Ojala, 1993).

3.2 WBL Model in Indonesia

As a pioneer in work-based learning in Indonesia is the Surakarta Mechanical Engineering Academy (ATMI) which has applied the principles of Production Based Education and Training conducted between real industries with an emphasis on market-oriented products, in which students participate and learn to work directly in production units (Triatmoko, 2001: 1). There is also another model, namely Mercedes-Benz (PT Mercedes-Benz Distribution Indonesia) which educate the needs of mechanics in automotive training as called by 3-year Automotive Mechatronic vocational training organized at MBDI Central Training Department in Ciputat with its materials including basic metal, basic automotive and advance technology in the field of commercial vehicle engineering with On-the-Job Training program at a car factory.

Astra Jakarta Manufactory Polytechnic, department of mechanical and automotive engineering conducted on-the-job training periodically for 9-12 months so that students will obtain competences as

intermediate experts in the field of engine maintenance. Likewise, United Tractors Tbk is engaged in business of maintenance and repair of heavy equipment.

Ariffin & Asmah, 2009 argued that between industrial world and educational institutions, both parties collaborate to access opportunities as a ‘win-win solution’ situation in which both parties benefit from the WBL Program (Ariffin & Asmah, 2009). This collaboration can improve relations between institutions and industry. For example, the automotive part of PT Astra as a training partner in the WBL program, PT Astra has prepared machines, equipment, and other supporters while students as executors as well as technicians and product marketing will create collaboration.

Findings through collaboration between the Community and PT Astra have used WBL in Diploma in the Automotive Program and finds out that WBL requires theoretical learning in the classroom and in the workplace (Yusuff et al., 2007).

3.3 Relationship Model Among Industrial Institutions

The relationship model between industry and industrial institutions describes relationship between industry and institutional system of technical and vocational education. Institutions are seen as the main source of new workers in various fields of work, and employers have the right to assess educational activities and products through their products, namely graduates.

The model in Figure 2 shows the relationship between institutional systems and industries that produce a number of graduates and workers with necessary knowledge and skills by industry today. Industry will benefit if the education taken by these institutions is in line with technological developments (Council of Ontario University, 1998).

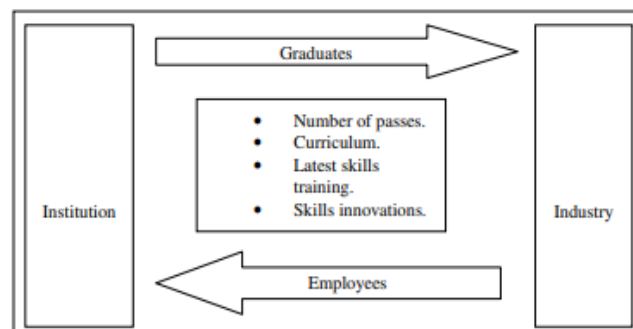


Figure 2. Ontario Relationship Model

Based on Figure 2 above, it is found that relationship between institutional and industrial systems serves as the main aspect in technical or vocational education. Educational institutions are places to improve certain skills and have responsibility for designing their products according to their own principles. Therefore, the role of industry in technical education institutions cannot be denied. Regardless of the quality of technical graduates produced by the institute, it must meet industrial criteria and demands. The products must meet industrial wishes.

Current curriculum and skills training must emphasize on skills aspects that meet the needs of employers and industry. Therefore, the two-way relationship between institutions and industry is important since it has mutual benefits for both parties, especially in producing workers who are knowledgeable and meet industrial demands.

3.4 Edmunds Model

The Edmunds model relates students, employers and educational institutions through training method (student-employer relations), education (student relations-educational institutions) and codification of knowledge (employer-institution relationship education) to WBL. Edmunds defines Work -Based Learning in Edmunds models as a condition in which learning experiences include students, employers

and Learning institution. In other words, there is active participation at least to a certain extent by each party. Edmunds did not agree that there are only two parties working simultaneously.

Figure 3 illustrates the Edmunds Model. It is found that the Edmunds model involves participation of three parties namely learners, industrial entrepreneurs and educational institutions in order to create successful WBL. Edmunds also suggested that industrial entrepreneurs or educational institutions produce knowledge by codifying it to any relevant academic needs to educational institutions. Edmunds also said that WBL is not similar to normal academics since it is directly related to individual work, certain work contexts and differentiated from general education (Edmunds, 2007).

From here, Edmunds proposed definition of work-based learning as an acquisition process of accredited knowledge and skills in the context of activities with the purpose to involve active participation from individual learners, organizations that employ them and educational or training institutions that work with mutually agreed curricula and mutual benefits.

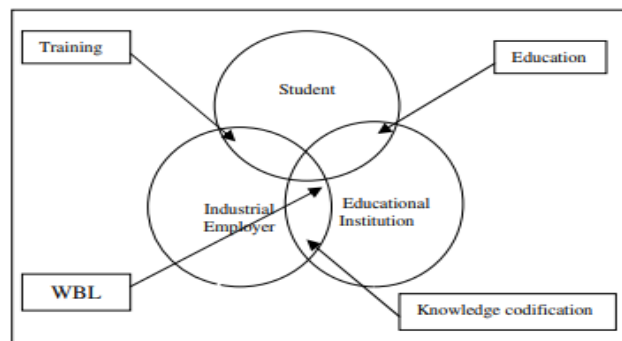


Figure 3. Edmunds Model

3.5 Development Model

The development model in this study refers to a variety of WBL models that have been widely applied by diploma programs and polytechnics of neighboring countries such as Malaysia, but in this development, it seeks to apply inversely proportional principles to the percentage of theory at 60% and theoretical practice in laboratory by 40%. According to Seagraves et al. (1996), learning element of the WBL program should be designed in a such a way in coordinated and integrated classroom and workplace with the curriculum and also assessment system.

WBL development of model (Fig.4) is ;

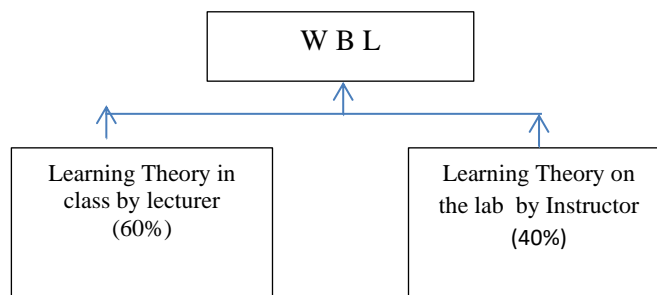


Figure 4.WBL Model Development

The WBL approach is similar to Boud and Solomon (2001), Baldwin and Clarke (2000), and Gray (2001) collaborative concepts. As Cunningham, Dawes, & Bennet (2004) in the Handbook of Work Based Learning suggest that the implementation of WBL-based education requires strategies, tactics and methods. The WBL program that is designed for students in Mechanical Engineering is basically based on Heat Transfer courses which are guided by theoretical lessons in which they have face

continuous learning for 5 times face-to-face in the laboratory. Afterwards, the students will be allocated 7 weeks back to class.

In the laboratory, students' works are based on basic knowledge and subjects as relevant topics to the case of Heat Transfer and use a touch of technology. One instructor will be appointed to a group of students and will guide students in carrying out laboratory tasks. Then the instructor (lecturer) will regularly evaluate students.

4. Conclusion

It is found that the WBL method requires involvement of students, educational institutions and laboratory facilities until industrial party. This will create an improved value attribute for students, since students will be superior in theory, academics and skills in the direct technical field. There are five models that have been reviewed, namely the Learning Model Based Industrial Engineering Academy (ATMI) Surakarta; MBDI Central Training Department in Ciputat, Astra Jakarta Manufactory Polytechnic majoring in mechanical engineering, Technical Institution Relationship Model; Edmunds Model. Therefore, it is necessary to expand this method in order to allow the three parties to obtain maximum benefits. The involvement of third parties is important in ensuring more systematically application of this method in the education system. To ensure this method works properly, relationships between the three parties must be maintained at all times.

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