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LEARNING OUTCOMES MAPPING OF THE THREE YEAR-ELECTRONIC ENGINEERING DIPLOMA IN LEVEL-5 PROFESSIONAL EXPERTISE OF THE NATIONAL QUALIFICATION FRAMEWORK

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ABSTRACT

The issue of enhancing national competitiveness, in ASEAN, has been strengthened since the establishment of ASEAN Economic Community in 2015. The recognition of graduate competence becomes very crucial for this era. Polytechnic as vocational higher education needs to prepare its graduates in order to compete in the job market, such as through professional certification. This study aimed at mapping the learning outcomes among graduates of the three year - diploma in Electronic Engineering in Polytechnic of Instrumentation and Electronic Control System on professional qualification based on level-5 Indonesian National Qualifications Framework Curriculum and Indonesia Industrial Standard Classification 2015. This study used a qualitative method. Data were collected through observation and interviews of the competent persons to provide related research data. The results showed that the learning outcomes of the three year diploma in Electronic Engineering were suitable for the work of the services and processing industry category. This map can be used to develop learning outcomes into a professional competence for a particular job in accordance with the qualifications of the graduate program.

Keywords: learning outcomes, professional, recognition

INTRODUCTION

In ASEAN region, the issue of enhancing the national competitiveness has been strengthening since the establishment of the ASEAN Economic Community (AEC) in 2015. The recognition of graduate competence has become crucial for education and training institutions around the world. Each country prepares its strategy to prepare its human resources, through formal and non-formal education. The approaches and policies adopted by each country depend on the role, social conditions of society, political situation and employment (Clarke & Winch, 2007; Cheng, 2005; ILO, 2015). Those factors influence the educational system and the long-term strategy adopted by each country. These differences also implicate the difficulty of skills building and the required working knowledge of the company. This is because specific skills in a certain company may not be required in other companies. In addition, vocational education still faces the fact that the nature and type of work are changing rapidly as the impact of information and computers technology (ICT) development in almost all sectors. Many job opportunities are emerging due to these technologies application, even many unexpected new jobs offer. On the other hand, new unemployment is getting bigger, for instance, because their work has been replaced with the production machines in the industry. It has been predicted by UNESCO since the 1990s through its research report. The report shows the type of service work will be a job opportunity which is increasingly needed (UNESCO, 1992).

Currently, it has been proven that IT-based jobs tend to be service job category. This work requires more complex competencies because it deals with many customers. This type of required skill is more generic and requires high knowledge. Therefore, the role of vocational higher education is very crucial for the present and the future. Globalization has forced and challenged many educational institutions to compete in preparing human

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resources that are compatible with their era. It makes standards of work competence are continuously improved. Vocational education is designed to concern with human resources development to cope the requirements of fast developing market (Wibowo, 2016). Wulandari et al. (2015) add that vocational education primarily prepare the graduates to work according to their respective fields.

Polytechnic as a vocational higher education institution, according to the law, is mandated to prepare human resources with the applied expertise of certain field (Regulation of the Minister of Research, Technology, and Higher Education of Indonesia, 2015). This preparation is to make polytechnics graduates can compete in the market both national and regional work. It is in line with the vision of Politeknik Negeri Bandung. The graduates' skills are expected to be used as a means to obtain decent work or able to work independently, as entrepreneurs, and even create jobs opportunity for other people.

Vocational education, both at the level of secondary education and higher education, is strongly influenced by environmental conditions, namely the development of science and technology, especially information and computers technology, socio-cultural change of society, politics, economics (Cheng, 2005). The fast and non-linear changes have forced vocational education to adjust the mindset of thinking in designing the curriculum. Many jobs require knowledge and high-tech skills (Allen & Velden, 2011). Therefore the role of the Polytechnic as a vocational higher education institution is significant in providing qualified human resources to undertake various new jobs. As an example, South Korea has set up their vocational education programs that are directly related to the work in the industry as their real step to develop the required human resources. This kind of education is carried out by an institution equal to Polytechnic in Indonesia, namely Korea Polytechnic Colleges (Chae & Chung, 2009).

The relevance of education and the world of work has always been the main issue. New methods and policies have been created, but the facts of unemployment due to the lack of relevance between education and the world of work always appear. Unemployment is always identified with inefficient education (Abduhzen, 2016). Various indicators have been developed to measure the relevance of education, such as through the absorption of graduates into the labor market. However, the absorption indicators call into doubt because, in fact, not all graduates work in accordance with the field of education and even some work under the proper qualifications. Learning methods have been attempted to be developed by implementing the Link-and-Match program that adopts vocational education learning methods from Germany. This method, basically, applies the concept of learning at school, college or work. Students can learn theory, knowledge and technology in the campus and they learn to work in the real working environment in the workplace (office or factory).

The establishment of ASEAN economic community (AEC) to create economic integration, single market production base, and freedom of the labor market, enabling the flow of products and labor among the countries. It raises the need for the competence or expertise recognition of workers and products produced by an industry. Recognition of competence or expertise and human resource development are vital for vocational education institutions (ILO, 2015). The recognition of expertise for workers or prospective workers has arisen the opportunities as well as challenges for every educational institution, especially vocational education and professional training institutions that are always associated with the preparation of skilled or semi-skilled workforce that suits individual needs as well as the job market. Polytechnic education programs need to be designed in such a way to make sure its compatibility with fluctuations in economic activity.

The products also need recognition where particular goods or work products of the industry must be high precision, for example the aircraft industry. It requires the assurance that the products have been undertaken by skilled persons in their field indicating with the certificate of expertise possessed by the workers.

In terms of educational institutions, the curriculum needs to be designed and developed to be flexible in facing unpredictable conditions but still can be used as a guide for lecturers and organizer at the study program level in preparing their graduates in order to have the required qualifications in a dynamic workplace. The developed curriculum needs to be periodically evaluated to keep it in line with the needs and changes. Good communication and cooperation between educational and industrial institutions need to be improved so that the preparation of human resources through education can be done better. Good cooperation can also trigger the productivity growth through applied research. Government support as a regulator that encourages the productivity of both products and the quality of human resources is needed to align educational and industrial activities. The role of vocational higher education is now increasingly important, as many jobs require high-tech knowledge and skills, especially those used for development like product development and applied sciences through research (Allen & Velden, 2011).

This study aimed at mapping the learning outcomes on the standardized works based on Indonesian National Qualifications Framework Curriculum known as KKNI and Indonesian Standard Industrial Classification known as KBLI 2015 and relevant to the expertise program from the three-year diploma (D-III) in the Study Program of Electronic Engineering Electronic Engineering in Polytechnic Negeri Bandung.

The research results in the form of competency maps for instrumentation and control system field in certain workgroups can be used to (1) develop learning outcomes into professional competencies for specific jobs, (2) develop lesson plans and teaching materials, (3) measure the appropriateness of education programs with employment, and (4) evaluate the curriculum being implemented and develop it for future program improvement.

Learning outcomes is the ability achieved by learners that are measured shortly after they complete education or training (Regulation of the Minister of Research, Technology, and Higher Education, 2015). It is a formulation of graduate competency consisting of attitude, knowledge and skill. Its formulation refers to the description of Indonesian National Qualifications Framework Curriculum and equal to level-5 for graduates of D-III education program (President Regulation, 2012). Learning outcome in the curriculum of D-III Electronic Engineering Study Program in Polytechnik Negeri Bandung as the case study in this research has been nationally standardized through the convention of a similar study program on November 5, 2015. Its standardization is then referred to as National Learning Outcomes and used as a reference for curriculum development. The curriculum based on the National Learning Outcomes is referred to Higher Education Curriculum 2016 which also known as KPT-2016 of the Study program of D-III Electronic Engineering.

Learning outcome, according to National Standards of Higher Education, consists of 3 groups of skills, namely attitude, knowledge and skills. In this research, the attitude is proper behavior and based on culture as a result of values internalization and actualization as well as norms, which it can be reflected in the spiritual and social life through the process of learning, student work experience, research or community service. The knowledge is a mastery of certain concepts, theories, methods or philosophy of the field of science, in this case the knowledge of electronic engineering obtained through reasoning in the process of learning, work experience and community service (Regulation of the Minister of Research, Technology, and Higher Education of

Indonesia, 2015). The skills are the ability to perform using the concepts, theories, methods, materials, and or instruments obtained by students through the process of learning, work experience, and or community service. The skills group consists of (1) general skills, such as language and communication skills, the ability to apply mathematics to the work; the use of information technology to search, to select and to sort the needed information to support the established work targets, and (2) special skills, i.e, the ability to perform specific job areas, such as designing Electronic Printing Boards (PCB) using software, assembling electronic components on PCB, installing electronic equipment on a system, and so on.

The learning outcome of similar study programs needs to be standardized and synchronized as one of the quality assurances of its learning outcomes. The standardized learning outcome can be used for the development of other educational standards, i.e content, process, learning outcomes assessment, lecturer and teaching staff standards, learning management facilities and infrastructure and required financing standards. The learning standard is formulated with reference to the description of the Indonesian National Qualification Framework.

Indonesian National Qualification Framework is a competency gap that can match, equalize and integrate between the field of education and the field of job training in the framework of work competence recognition in accordance with the structure of work competence in various sectors (Presidential Regulation, 2012). The equivalence of the qualifications of formal education graduates can be seen in Figure 1. Graduates of D-III education level have qualifications equivalent to level-5 KKNI. The competence according to the Presidential Regulation can be obtained through formal, informal, non-formal or work experience. Recognition of the competency can be done through a competency test conducting by the authorized institution.

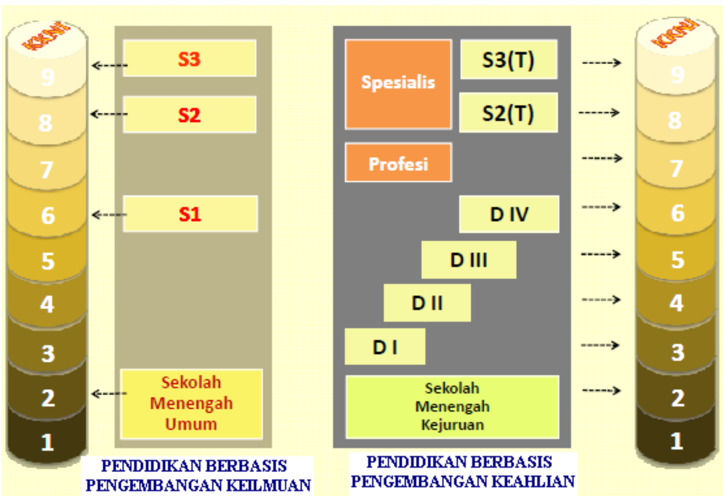

Figure 1. Equalization of Education Level at KKNI Level

The description that exists at every level of KKNI is still normative so it needs to be interpreted again into measurable statements. The interpretation needs to be linked directly to the work competence in the field or the career in the workplace. Furthermore, this competency is referred to as the competence of the profession.

The professional competence can be made based on Indonesia Standard Industrial Classification which also known as KBLI, which is standardized business yclassification and published by the Central Bureau of Statistics. The latest KBLI is published in 2015 in the form of Regulation of the Central Bureau of Statistics No. 95 the Year

2015. KBLI is made primarily as a reference for economic activity, granting of a business license, and as a reference for determining the qualification of investment license. KBLI is made with reference to the 2008 International Standard of Industrial Classification of All Economic Activity (ISIC) published by United Nations of Statistical Division (UNSD). KBLI is also used as the basis for the preparation of Indonesian National Work Competence Standards which also known as SKKNI. In other words, work competence must be arranged based on the needs of a particular job competence. Professional competencies are grouped according to work groupings in KBLI 2015.

The grouping of work in KBLI 2015 is determined based on economic activity which is categorized into two, namely: economic activities that produce services and economic activities. The activities that produce services are categorized in the service industry, while the economic activities that produce the goods are called processing industries (Ministry of Labor of Indonesia, 2015). Both the service industry and their respective goods are coded up to 4 digits (ISIC standard). In KBLI 2015, the standard code is made up to 5 digits. The 5th digit is made specifically for the needs of the business field in Indonesia. If it is required, the code can be made up to 6 digits, especially for existing jobs but it can not be included in the existing category on KBLI 2015.

The grouping of processing industry activities in KBLI does not distinguish whether the economic activity is carried out by machinery or hands, in factories or home, modern or traditional industries. The grouping is based on the type of productive activity of goods and services, not the commodity.

METHOD

This study used a qualitative method. Data were collected through the document search, field observation, interviews with Human Resource Development (HRD) managers in industries, alumni, and students who have implemented Field Work Practices. The study was conducted through the steps as shown in Figure 2.

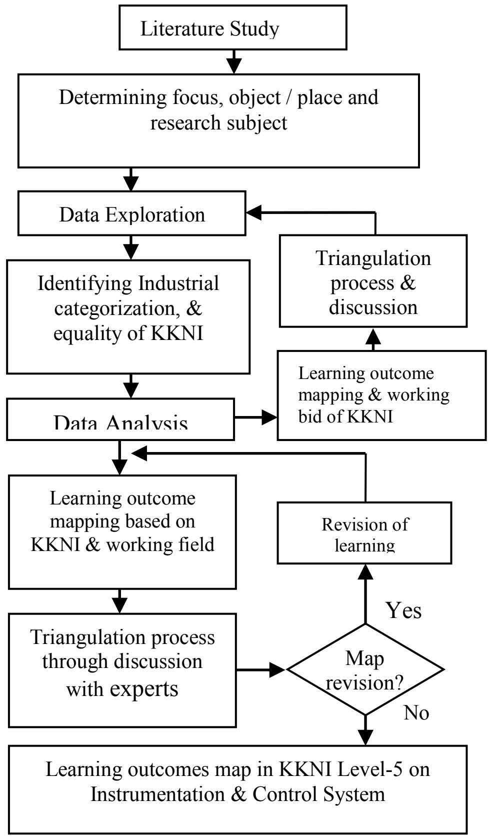

Figure 2. Research Methodology

The learning outcomes which has been agreed by similar study program in 2015 at national conference similar study programs, is explored through the curriculum document of D-III Electronic Engineering Study Program of Poiteknik Negeri Bandung. Learning outcomes, then, grouped into three according to the achievements of each level of education year.

Group work data is explored through field studies, especially related to instrumentation and electronic control systems or industrial automation systems. This was done with the consideration that all industrial process automation controls had mostly used electronic devices. The required job competence standards were explored through direct field observation and cross-check through HRD managers, such as, the determination of competency standards, professional certifications, and the careers of employees in the company. The field observations were also conducted as a validation effort for both content and competency data.

The data from the field was then processed by grouping the existing jobs in the categories of work, basic classes, and work groups that have been standardized in KBLI 2015. Each class consisted of several sub-groups, and each sub-group included several work groups. The next step was to map learning outcome to the workgroups. The mapping of economic groups was done through the mechanism as shown in Figure 3. Learning outcome in the curriculum was categorized based on the achievement target of learning according to the level of education per year. Every level was mapped to the working group on instrumentation and control systems and occupational groups in the cognate field. This map was then broken down into the working group map, the subgroup of work, and each subgroup was described again into a map of work groups.

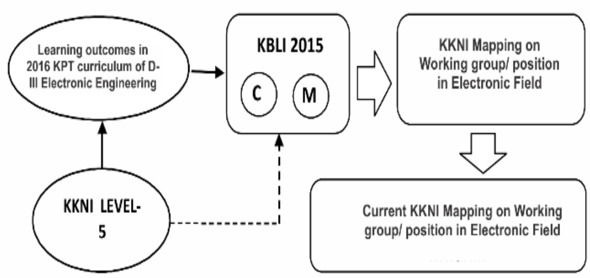

Figure 3. Mapping Mechanism

Learning outcomes in 2016 KPT curriculum of D-III Electronic Engineering Study Program is described based on the 5th level KKNI description. It was then mapped based on the competence qualifications for work performance in electronics, particularly instrumentation and control systems. The mapping results were then sent back to the industry for review and verification. When there was no difference in the very principal perception between polytechnics and industry, then the mapping result can be used as a document of study program for the material foundation for the study program development in the area of academic, facilities and infrastructure, fieldwork practice and others.

RESULTS AND DISCUSSION

The result of exploration of documents from KBLI 2015 showed that the categories of economic activities described into working groups which was named and coded with one capital letter from A to U. The category of A is a work group included in the areas of Agriculture, Forestry and Fisheries; category of B is an occupational group included in the area of Mining, and Excavation; C is an occupational group included in the Processing Industry area; D is the occupational group included in the areas of Procurement of Electricity, Gas and Steam/ Hot Water and Cold Air; E is an occupational group included in the area of Water Treatment, Wastewater Treatment, Waste Processing and Recycling, and Remediation Activities; F is the occupational group included in the Construction area; G is the occupational group included in the area of Large and Retail Trade; H is an occupational group included in the area of Freight and Warehousing; I is a group of occupations included in the Provision of Accommodation and Drinking Water Supply; J is the occupational group included in the area of Information and Communication; K is an occupational group included in the area of Financial Activities and Insurance; L is a work group included in the Real Estate area; M Professional, Scientific and Technical Activities; N is an occupational group included in the area of Lease and Lease Activity without the Right of Option, Employment; O is a group of occupations belonging to the area of Government Administration, Defense, and Mandatory Social Security; P is an occupational group included in the Education area; Q is an occupational group included in the area of Human Health Activities and Social Activities; R is a work group included in the Arts, Entertainment and Recreation area; S is for Other Services Activities; T included in the area of the Household Activities as Employers, Activities that produce Goods and Services by the Household; U is a group of occupations that are included in the area of the International Agency's Activities and other international extra agency.

Based on the occupation category and description of level 5 KKNI and learning outcome description at KPT Curriculum 2016 D-III Electronic Engineering Study Program, the closest job to the learning outcome is a kind of work consisting of service industry category (Code M) and processing industry (Code C). It does not mean that the competence of D-III Electronic Engineering graduates is not in accordance with work groups from other areas, but the meaning is the role of electronics is limited in other areas of work. For example, in the construction work area, the work related to electronic competence only the installation of electrical and electronic equipment. These jobs can be done by graduates of vocational high school (level-2 or level-3 KKNI).

After the most suitable job category is selected, the next step is to select the main group of work that best suits learning outcomes of D-III Electronic Engineering Study Program. Based on the job clusters description that exists in the category of C, the principal group that best suits the learning outcome are the main group of Computer Industry, Electronic Goods, and others. This principal group consists of the Industrial Components and Electronic Board Working Group; Computer and Complementary Industries; Electrical Audio and Video Equipment industry; and Measuring Equipment Industry and Test Equipment. The learning outcomes mapping of the C category is shown in Table 1.

Table 1. Learning Outcome Mapping in the Field of Processing Category (code C)

Processing Industry Category (Code C) Main Group: Computer Industry, Electronic and Optic Group (26)		
Group/Code	Sub-Group/Code	Work Group
Industry Components and Electronic Board (261)	Semiconductor Industry and Other Electronic Components (2612)	Component creation (26120): Passive, active components, including interface card, smart card.
Computer Industry and Its Equipment (262)	Industrial Computer and or Computer Assembly (2621). The Computer Equipment Industry (2622) includes I / O (printer, monitor, keyboard), storage equipment	Manufacture of various computing machines (26210) Industrial Computer Supplies: computer equipment manufacturer (26220)
Audio Industry Equipment and Electronic Video (264)	Other Electronic Audio and Video Equipment (2649)	Electronics and Audio-Video Manufacture for households & Motor vehicles, amplifiers and Musical instruments (26490): Special design of control system (26491)
Industry Tools, Test Equipment Navigation and Control, and Time Measures (265)	Industrial Measuring Equipment, Test Equipment, Navigation And Control Equipment (2651)	Measuring Equipment Industry and Manual Test Equipment (26511) Industry of measuring instruments and electronic test equipment navigation and control equipment (26513), including: aircraft industry; industry flow meter Industrial test equipment in industrial processes (26514)

Table 1 shows that the work in the processing industry category in the main group of computer, electronic and optical manufacture consists of 4 (four) groups, namely (1) Electronic Components and Board Industry (code 261) which includes the work group for making passive electronic components R, L, C, Trafo) or active (e.g. Diode, transistor, etc.), including the work of making interface cards and making smart cards, (2) Computer and Components Industry (code 262) covering a group of work making of various computing machines and computer equipment, such as I / O, printer, keyboard, and memory equipment; (3) Electronic Audio and Video Equipment Industry (code 264) covering work on the manufacture of audio and video equipment for household appliances and motor vehicles, amplifiers and musical instruments; and (4) Industrial Measuring Instruments, Navigation and Control Equipment Test Equipment, and Time Measurers which includes the manufacture of manual test equipment, electronic test equipment, special navigation tools for the aircraft industry as well as meter flow meter.

The main class of work in Service Industry category (Code M) consists of two main groups namely (1) Architecture and Engineering Activities, Analysis and Technical Test (Code 71); and (2) Research and Development (R & D) (Code 72). Among these two groups, Analysis and Technical Test, including a group of maintenance and repair of electronic devices and measuring devices in navigation systems, control systems and industrial automation systems that use the electronic control are the most appropriate to learning outcomes of the Study Program of D-III Electronic Engineering.The works which are included in the main R & D category consist of the realization of the design result, the design test with the simulator, the prototype, the prototype testing (the function and the performance test). The results of learning outcomes mapping on jobs falling within the Service Industry category (code M) are shown in Table 2.

Table 2. Learning Outcome Mapping in the Category of Industrial Service (Code M)

Service Category (Code M) Main Group: Architecture and Engineering Activities, Analysis And Technical Testing (71)		
Group/Code	Sub-Group/Code	Work Group
Analysis & Technical Tests (712)	Technical Analysis & Testing (7120): including performance test of electronic equipment; includes physical test, electrical, mechanical (for Lab Services); maintenance and repair of electronic tool (periodic test related to security & calibration Meteorology)	Physical Test Activity (71200) Product Certification (71201) Lab Testing Services (71202): Security-related Periodic Test Calibration/ Meteorology Services (71205): including maintenance of electronic instruments
Main Group: Research and Development (R & D) (72)		
Research & Development, Sciences, Technology and Engineering (721)	Research & Development of Sciences, Technology and Engineering or R & D (7210)	R & D Technology and Engineering (72102) encompasses R & D of engineering science and technology among branches of science and engineering

All work related to electronic products, whether electronic components or systems are incorporated in the Main Group: Industrial Computers, Electronic and Optical Goods (Code 26). This main group distinguishes industrial activities into 4 (four) categories of work, namely: Industrial Components and Electronic Boards (Code 261), Industrial Computers and Equipment (Code 262), Electronic Audio and Video Equipment Industry, and Measuring Equipment Industry, Navigation and Control Equipment, and Time Measurement Tool (Code 265). Each Group is split into several sub-classes which is further translated into Working Group. The information on the production process activities of goods and services of each working group shall be used as a reference to determine the qualifications of workers (a person who carries the production activities). The workers' qualifications to perform certain jobs described and formulated as Work Competency Standards (SKK). If this SKK can be agreed upon in the national convention it could become the Indonesian National Competency Standards (SKKNI). Each SKKNI is synchronized with the corresponding KKNI level. The next step is to map the learning outcome that has been nationally standardized and it is set by D-III Electronic Engineering Study Program in the appropriate work area based on Table 1 and Table 2.

Learning outcome in 2016 KPT curriculum is mapped to the appropriate work area, both the employment group and the required HR qualifications. HR qualifications are determined according to level-5 KKNI for the field of instrumentation and electronic control system expertise. Learning outcomes mapping is made per academic year. The mapping results are shown in Table 3 through Table 5. Based on Table 3 to Table 5, it can be shown that learning outcome of D-III Electronic Engineering Study Program can occupy various groups of work that can be clustered into two, i.e. related to the processing industry and the service industry. The grouping can also be seen from the level of work according to the complexity and degree of difficulty of work. This grouping includes the work belonging to operator competence, equipment testing and product testing, maintenance and repair, assembly or installation of systems, design, and work can be classified as development.

The work belongs to the operator is operating the electronic measuring equipment, control system equipment in the production process by using electronic-based control equipment. This ability can be achieved by the first year students.

Table 3. Learning Outcome Mapping of the First Year

Year	Learning Outcomes	Work-Groups	Required Competence
I	1. Mastering basic electrical, electronics, and applied physics; 2. Using mathematics for electronic analysis and troubleshooting; 3. Using a measuring instrument to test the circuit by applying K3, 4. Using language for effective communication, 5. Responsible for individual and group work	1. Operating of electronic equipment for instrumentation and audio 2. Testing and measuring circuit, measuring instrument and test of electronic equipment 3. Quality Control (QC) of electronic products: components, series and electronic equipment	1. Implementing Job safety analysis (JSA) 2. Implement OSH procedures and principles in all work processes including measurement and testing. 3. Operating electronic equipment 4. Making a complete technical report with analysis, conclusions and recommendations.

Table 4. Learning Outcome Mapping of the Second Year

Year	Learning Outcomes	Work-groups	Required Competence
II	1. Mastering basic theoretical concepts of analog and digital technology 2. Mastering the basic programming, programming, 3. Maintaining and repairing the circuit or electronic system 4. Designing circuit or electronic system 5. Designing electronic circuits for control and instrumentation systems using PLCs by applying K3 procedures and principles	1. Calibration of electronic measuring equipment 2. QC products-2 electronics: components, series including cards, and electronics equipment 3. Design and realization of electronic circuits and automation systems 4. Setting the control system for a particular plan 5. Realization of circuit design result for SCADA / HMI 6. Maintenance & repair of electronic circuit and or system	1. Implementing Job safety analysis (JSA) 2. Applying K3 principles and procedures in all work processes 3. Using electronic measuring equipment 4. Design and make PCB according to the circuit diagram 5. Testing the circuit and the electronic equipment 6. Track the source of damage in the circuit and / or electronic system 7. Making a complete technical report with analysis, conclusions and recommendations.

Table 5. Learning Outcome Mapping of the Third Year

Year	Learning Outcomes	Work-groups	Required Competence
III	Applying knowledge and skills in the workplace and able to make a plan (a proposal) as well as implementing the final project	1. Calibration of electronic measurement equipment 2. QC products: electronics components, including cards, and electronics equipment. 3. Designing the control system for certain plan. 4. Setting the control system for a particular plan 5. Designing and automation system 6. Designing SCADA / HMI series	1. Implementing Job safety analysis (JSA) 2. Applying procedures and principles of OSH in all work processes 3. Using measuring equipment for both calibration and test of electronic products 4. Makeing PCB according to the circuit diagram 5. Setting the control system for a particular plan 6. Designing and realize SCADA / HMI circuit 7. Writing full technical reports (measurement data, analysis, and recommendations

In the second year, the ability to increase at higher levels of work such as realizing the design or assembling the series based on working drawings, developing existing circuits, making programs on programmable electronic devices for industrial control and instrumentation systems, and industrial automation systems such as creating microcontroller-based control equipment, PLC-based electronic equipment, and mobile data-based electronic equipment. In addition, students in the second year can also perform electronic equipment testing and measuring equipment, maintenance and repairing electronic equipment, electronics-based process control system. This competency should be applicable if the fieldwork practice is carried out at the end of the second semester in the second year.

In the second year, the ability increase into higher levels of work, such as realizing the design or assembling the series from working drawings, developing existing circuits, making programs on programmable electronic devices for industrial control and instrumentation systems, and industrial automation systems such as creating microcontroller based control equipment, PLC-based electronic equipment, and mobile data-based electronic equipment. The students in the second year can also perform electronic equipment testing and measurement equipment, maintaining and repairing electronic equipment, electronics-based process control system. This competency should be applicable if the fieldwork practice is carried out at the end of the fourth semester in the second year.

In the last year (third year), the students are expected to have competencies to design a more complex circuit such as card interface, smart card, design control system and monitoring tool based on a microcontroller, including micro-controller that has been equipped with an interface to various actuators or specific plan. This competence is able to support in arranging proposal and carrying out the applied scientific activities in the form of Final Project.

The student competencies from the first to the third years can be mapped briefly as shown in Figure 4. The competencies are clustered in accordance with the standards of KBLI 2015. Figure 4 shows that the competence of students up to the second year occupies a lot of work groups belonging to the category of Service Industry. They are able to enter the work belonging to the category of Processing Industry after joining the third year of education. The data were collected from the students who have implemented internship.

Based on the results of the survey on the students who conducted the field internship between 2015 and 2017, most of them were directly involved in maintenance and repair work (60%), a small portion (10%) were involved in R & D work, the rest engaged in non-specific jobs such as monitoring, repair work, compiling SOP, assembling circuit on PCB and entry record.

Based on data from above internship, the most students are responsible care and repair. R & D work in KBLI 2015 is included in the Service Industry category (code M). Jobs assigned to the students in the R & D division include testing the function and performance of the circuit or equipment of design and prototype design from the design results.

The work undertaken in the maintenance division includes measuring the performance of the equipment being repaired until the component replacement. At the end of the job, the student is required to make a technical report in which the format has been provided or standardized by the company. The alumni data on 2015-2016 shows that more than 75% of alumni work in various companies, and less than 3.3% are entrepreneurs. This shows that the dependence of graduates with conventional companies is very big. This is related to educational materials
and training courses that still focus on the mastery of knowledge and the formation of technical skills than hard-skills. It is necessary to develop soft-skills through integrated training with the subject matter of each course.

Briefly, learning outcome mapping in various workgroups can be shown in Figure 4. The obtained outcomes in the year I & II are able to occupy the work included in the service industry covering the work of operating electronic equipment, calibrating electronic measuring equipment, testing for product quality control (QC), assembling electronic equipment including assembling components on electronic printing boards, and repairing equipment measure and control system under supervision or expert. The third-year students begin to have responsibility for the work included in the category of processing industry which includes the work of realizing the design results of the engineers, testing for R & D purposes. To make learning outcome development strategy become profession standard, it can be done through various ways such as the implementation of fieldwork practices or internship in the industry with more intensive cooperation between Polytechnic and industry (Handayani, 2013).

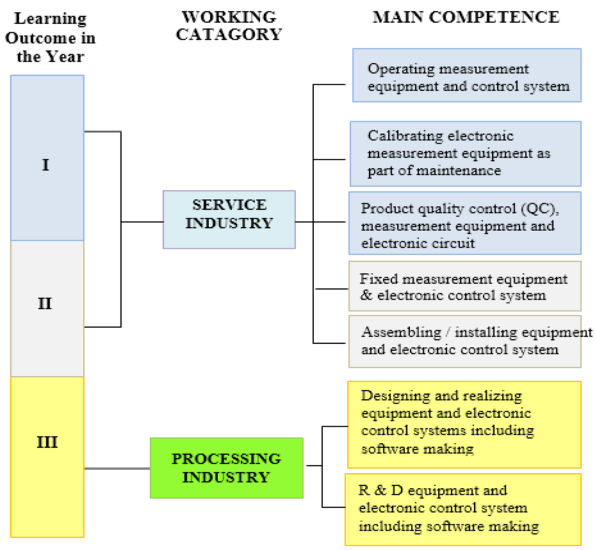

Figure 4. Mapping of Learning Outcomes
of D-III Electronic Engineering Study Program on Work Category

The first and foremost thing that needs to be prepared to realize the process of learning outcomes transformation into professional competence through internship activities is to change the paradigm of thinking about the internship itself (Handayani, Making Apprenticeship Meaningful for Polytechnic, 2012). During this time, the internship program is carried out with lack of preparation. The students seek their own practice place without knowing what to do in the industry later on. The industry also has difficulties in determining the work formation in the company because they do not know exactly the ability or competence of students who will perform practical work in the company. The lack of communication between the polytechnic and the industry resulting in an information gap between the two parties.

Various efforts have been done to improve communication between educational institutions. Particularly, polytechnics and industry try to increase the competence of polytechnic graduates such as by inviting a speaker from industry to polytechnic at least once a year to be guest lectures, having industrial visit both students and lecturers, and discussing the curriculum draft or revision. The curriculum has also been conducted periodically but the competence of graduates, in general, still cannot compete well in the national labor market even more international level. This is indicated by the absence of polytechnic graduates of, especially D-III Electronic Engineering program that entered the international working area in the last 5 years. In other words, the communication improvement efforts have not been able to improve the students' performance if it is viewed from the learning outcome standard that is equal to the standard work of the profession in the industry.

The process of transforming learning outcome into professional competence cannot be done only by updating the curriculum but in reality, it only enriches the teaching materials, even just adds and reduces the course. The assessment system is one of the causes that hinder the transformation process (Handayani, Finding The Missing Link In The Design of Polytechnics Competency-Based Curriculum, 2014). The undertaken assessment by the polytechnic is still focused more on the academic content since the assessment only performed by the lecturers (internal assessment) without involving the industry party; a specific assessment for professional competence through SKKNI packages need to be made.

Based on SKKNI document investigation, there are only a few SKKNI of electronic field-level 5 KKNI work, especially the instrumentation and electronic control system. This concern should be proposed by the Polytechnic to Ministry of Labor through a national convention involving the related industries, related professional associations, professional certification bodies and polytechnics. Therefore, it is necessary to prepare a competent KKNI map with learning outcomes of D-III Electronic Engineering Study Program as the development of learning outcome mapping as shown in Table 3 through Table 5 and Figure 6.

The qualification of D-III graduates occupies a professional position as Technician level-2 (Technician-2) at level-5 KKNI. The mapping of Table 6 and Table 7 is developed based on the competence description of on KKNI and KBLI 2015. The workgroup is based on the main function of the work. Each category of work can be derived or decomposed into several subgroups, and each subgroup of work can be described further into several occupational groups of work groups that will become the recipients of SKKNI packages. SKKNI is issued by the Minister of Labor, Republic of Indonesia. It needs a deeper study to get competency units that will be grouped into SKKNI proposal packages. Table 6 and Table 7 show different groups of occupations and responsibilities among the 5 level, its lower-level and its above level which can be seen from KKNI level, both for the jobs in the categories of manufacturing and service industries. This map can be used to design the training materials and required competency testing to meet the appropriate competency qualifications.

Table 6. KKNI Mapping For a Working Group of Processing Industry Category

KKNI Level	Position	Main Fuction					*)
		Blank PCB Making	Assembling PCB circuit	Creating certain tool	Creating control tool	Creating monitoring system	
9							
8							
7							
6	Junior Engineer	Designing electronic circuit/ module	Supervising the assembly	Checking the working result of the tool	Designing control equipment Supervising the production of electronic control system tools	Supervising the work /product of monitoring system tools	
5	Level-2 Technician	Make a single layer of PCB Make multilayers PCB	Designing component layout on PCB Measure component assembly results on PCB	Making / producing special electronic equipment: Interface cards, Converter, Actuator, Database acquisition system	Making / producing control equipment Assemble the control tools	Creating / producing equipment for SCADA-based monitoring system and mobile phone	
4	Level-1 Technician	Helping the PCB manufacturing process	Soldering the PCB components on	Documenting the production result	Documenting the production result	Documenting the production result	
3							
2							
1							

*) it can be developed for other products

Table 7. KKNI Mapping for a Working Group of Service Industry Category (M)

KKNI Level	Position	Main Function					
		Operation	Calibration	Testing & Analysis	Assembling & Manufacture	Maintenance & Repair	R&D
6	Supervisor /junior engineer	Checking preparations; Giving permission for operation; monitoring the execution; Processing report data from technician	Planning a physical test, verifying statistical test results	Checking test results Making recommendations on test results Implementing product certification test	Managing and supervising assembly work	Managing and supervising maintenance and repair work Analyze measurement / testing results	Coordinating with other work groups Designing or developing new products
5	Technician -2	Operating electronic measuring equipment Operating electronic devices on the control system. Operating electronic devices on industrial automation machines Operating microcontroller based electronic devices Operating PLC-based electronic devices SCADA System	Calibrating electronic measuring equipment Calibrating electronic devices on production machines Calibrating the electronic device on the process control system	Conducting a physical examination of product quality Performing product performance measurement: components, modules, electronic equipment Conducting measurement of electronic measurement equipment on control systems and industrial automation systems, microcontroller based measuring equipment and or PLC Testing software supporting the operation of electronic control / automation system	Assembling the electronics systems or electronic instruments on control systems and / or industrial automation systems	Implementing regular maintenance and repair of measurement equipment and electronic devices including performance test of measuring equipment and other electronic devices Implementing emergency maintenance and repair of measuring equipment and electronic devices Implementing maintenance and repair of software for electronic device control system	Realizing the design result from the engineer in the form of prototype Modifying the circuit or equipment or software that supporting the operation of existing electro-equipment
4	Technician -1	Preparing equipment and operating conditions	Listing the calibration test results	Physical Measurement according to Work Order (PK)	Assembling according to drawing work	Implementing maintenance & repair according to work orders	-

CONCLUSION

In conclusion, this study reveals that (1) The expected learning outcome in KPT Curriculum 2016 of D-III Electronic Engineering Study Program is to achieve some of the labor market needs, especially in the field of instrumentation and electronic control system (2) The learning outcome on KPT Curriculum 2016 of D-III Electronic Engineering Study Program has the potential to be developed to become several profession competences, particularly in the workgroup of instrumentation and electronic control system field (3) The jobs that can be completed by the students during their industrial internship are operators, technical testing, maintenance and repair of the equipment of electronic, measurement and the production process (4) The work belongs to the Research and Development (R & D) can be performed by some students under the supervision (5) The portion of production work formation is not yet occupied by the graduate of D-III Electronic Engineering Study Program. The breakthrough strategy is urgently needed to prepare a curriculum that is able to train students to become more independent and initiative in creating product innovation for both goods and services by utilizing their knowledge in the field of Instrumentation and Electronic Control System.

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