CURRICULUM MANAGEMENT AND LEARNING DESIGN USING TEACHING FACTORY IN INDUSTRIAL REVOLUTION 4.0 ERA: MACRO, *MESSO* AND MICRO LEVELS

by
Maman Suryaman
Universitas Singaperbangsa Karawang
Email: Maman.suryaman@fkip.unsika.ac.id

Abstract

The global market created in the industrial revolution era 4.0 requires human resources that have skills and soft skills in accordance with market needs. Educational institutions are challenged to be able to adapt to produce resources that can meet market needs. Therefore educational institutions must be able to provide an educational environment adapted to the real conditions of the global market industry, so curriculum management and learning are needed in line with the needs of the industry. One strategy that can be implemented into the curriculum and teaching is the teaching factory model which is a learning model that provides a real environment for students to develop skills and understand the challenges involved in daily industrial practice. This study aims to make curriculum management and learning design at the macro, messo, and micro level using the teaching factory so that it can produce human resources who are ready to face the challenges of the industrial revolution 4.0.

Keywords: Industrial Revolution 4.0, Global Market, Teaching Factory

INTRODUCTION

The industrial revolution 4.0 is characterized by the use of the principles of automation, the internet of things, engineering learning and artificial intelligence that have a very significant impact on all fields, especially in the industrial field. Industry is required to be creative and innovate and adapt these principles so as to create a competitive advantage in order to remain competitive. Educational institutions as supply from industry must be able to produce output that can adapt to the principles of automation, internet of things, technical learning and artificial intelligence so as to create a link and match between supply and demand.

The initial step of an educational institution to be able to create a link and match between supply and demand is to formulate a formulation that is in line with the needs of the industry, which is then used into curriculum management and implemented in the learning process. In compiling formulations in accordance with the needs of the industry, educational institutions need to consider how to create a learning environment that suitable with the conditions of industry, so that students can develop skills and understand the challenges faced in the industrial world. With this suitability, it can create competencies, qualifications and knowledge for students. To meet the specific prerequisites of a job in a particular industrial field, human resources require certain qualifications which consist of knowledge, abilities and skills.

The ability of students to act in complex situations requires the development of comprehensive competencies that are not just knowledge transfer. Knowledge is a basic element of the concept of competency based on the right rules, values and norms that can influence actions and create personality. When students receive information and apply it, they can create experience, skills and knowledge. With the increase in experience and knowledge, the next ladder is competency and

ISSN No. 1978-3787 (Cetak)
ISSN 2615-3505 (Online)

competitiveness. (Abele, E., Metternich, J., & Tisch, M., 2018).

The teaching factory model can be used to be adopted into curriculum and teaching management as a learning concept that can integrate learning activities, innovation and research involving industry and academia. (Chryssolouris et al., 2016; Chryssolouris, G., Mavrikios, D., & Mourtzis, D., 2013). The teaching factory concept is based on the notion of triangles of knowledge, namely knowledge, qualifications and competencies, which originate from medical disciplines, namely medical schools that operate in parallel with hospitals with the aim of combining work and learning environments so that realistic and relevant learning experiences emerge. (Chryssolouris, G., Mavrikios, D., & Mourtzis, D., 2013). Teaching factories follow a two-way knowledge channel where factory topics are used as the basis for new synergy models between academics and industry, while knowledge channels are used as a medium to exchange new ideas and solutions that can balance time and costs to learn and test solutions and deepen industry and academic knowledge through production innovations or real life problems. The two-way channel includes two schemes namely "factory to class" and "academy to industry" schemes. Channels from "factory to class" aim to transfer the factory environment to the classroom, while the factory location is used with the purpose of teaching to increase the knowledge in the process of industrial practice every day. This mechanism allows students to understand the factory environment in whole context. (Chryssolouris et al., 2016).

Modulation of the teaching factory concept describes the option of "factory to class" operations which are presented in four categories. the first is a factory, represents a module that fits the production area and the processes involved in the teaching factory. The second category defines curriculum or study content delivered in the teaching factory. The third category is filled by delivery mechanism module which plays a role in communication of knowledge and ability to interact between factories and classes. The fourth category is the use of ICT dedicated to supporting the teaching factory process.

In a design-oriented approach, teaching factory developed three perspectives. First, The factory perspective can mean that the teaching factory interpreted as a real production environment. Second, learning perspective can be intended that the teaching factory interpreted as a complex learning environment. Third perspective is a combination of both perspectives, factory perspectives and learning . However, the design-oriented approach to the teaching factory, according to Darmstandt, has the disadvantage that factory teaching is more dominant in the technique and neglects didactic in the learning system so that there is no detailed procedure model, teaching factory teaching modules are rarely designed to goal oriented or competent. Beside it, goals that are often not specified and the absence of practicable methods or procedures to measure achievement of goals, in many cases the transfer of learning from the teaching factory in a factory environment is actually hampered by a lack of user orientation. To overcome the design problem, it is necessary to develop competency-oriented designs with three levels of design, they are macro, meso and micro levels to adjust the design of right learning structure. (Tisch, M., Abele, E., & Metternich, J., 2018).

The macro level focuses generally on design of a comprehensive education program. This macro level includes technical social infrastructure, program content to be designed and basic didactic concepts. The meso level focuses on designing teaching activities or learning modules. The design of learning module not only includes the sequence of the learning process but also the planning of the ability to change the social-technical factory infrastructure. At the micro level, in general learning scenarios and learning resources are designed. At the micro level, the teaching factory consists of certain learning situations that are part of the learning module. The design of learning situations includes didactic - methodical design of the individual phase and preparation of the factory environment that is used as a support for learning, learning materials, learning media and learning products into one.This study aims to describe curriculum management design and learning at the macro, messo, and micro levels using micro teaching so that it can produce human resources who are ready to face the challenges of the industrial revolution 4.0.

METHODS

This study uses a descriptive qualitative approach to describe management curriculum design and learning in the context of implementing the teaching factory. The object of the implementation of the teaching factory is the Vocational Middle School (VMC). This object was chosen because it is an institution that organizes learning and learning processes that focus on producing output that is ready to compete against the challenges of work.

RESULT AND DISCUSSION

The results and discussion of this study are divided into three, namely curriculum management design and learning at the macro, meso and micro level.

At the macro level several things are formulated, including; general objectives and framework; learning target; conceptual planning and detail; checking and modularization.General goals and framework; in this section defined general goals and frameworks, requirements, targets and conditions.First, the condition of the learning factory specific framework, company objectives, and organizational requirements identified in relation to the learning system. Curriculum structure of teaching factory at SMK Al-Mufti , including; (1) Motorcycle service center services; (2) Car service center services; (3) Computer service center services; (5) Production of ruberr components; (5) Production of motorcycle hardness wiring.

1. Design factory teaching curriculum management and learning at the macro level to make the factory teaching design curriculum management and learning at the micro level, researchers formulated several things including general goals and frameworks, target learning, conceptual planning and detail, checking and modularization. General goals and frameworks can be defined as prerequisites, targets - targets and conditions. Here are the steps in the design process of teaching factory curriculum management and learning at the micro level:

a. Identify conditions for specific teaching factory frameworks, company goals, organizational prerequisites related to learning systems. This identification is done by analyzing in advance the work and the educational environment. Analysis of the world of work begins with an analysis of the structure of positions, jobs, duties and activities. A position describes several jobs, the work describes several tasks and tasks describing several activities. The following structured analysis is related to positions, jobs, duties and activities:

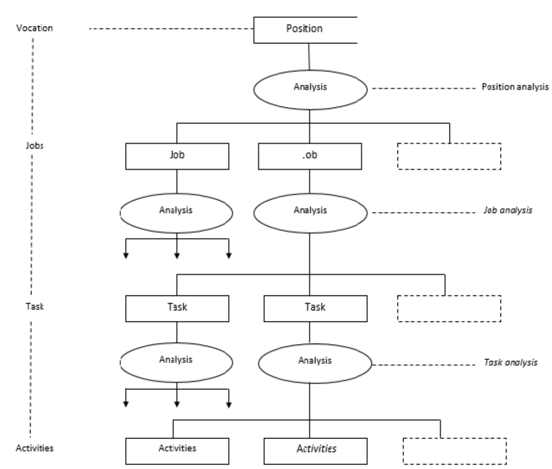

Figure 1. Position structure, employment, duties and activities

ISSN No. 1978-3787 (Cetak)
ISSN 2615-3505 (Online)

From the description of the structure above, it can be concluded that the structure of office, work, duties and activities will form a pyramid, where the position is at the top and the activities are basically. Whereas in the middle there are jobs and tasks. In simple terms it can be described as follows:

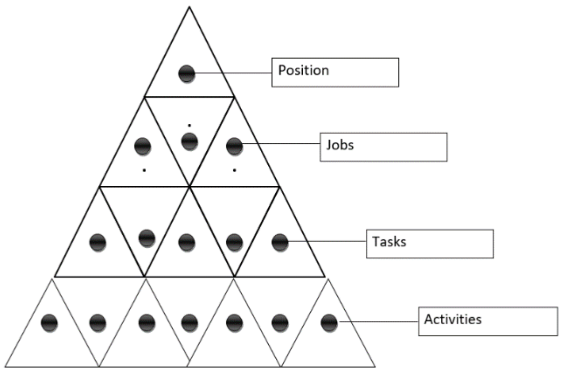

Figure 2. Position pyramid

Furthermore, analysis of study programs is carried out based on the demands of positions of work by seeking equality through comparison between work and education environment. In education there are two structures, namely structures related to curriculum material and objectives in the formulation of competencies. Position in work environment is equivalent to a study program or program of curriculum material expertise and expertise competence in purpose. Employment in the world of work is equivalent to vocational subjects in curriculum material and the purpose of subjects competency . The task is equivalent to the essential subject matter in the curriculum material and competency standard. Whereas activities are equivalent to the sub-items of essential materials in curricular material and objectives basic competencies. Visually the analysis of study programs based on the demands of work environment can be described as follows:

Work Environment	Educational Environment	
	Curriculum Material	Objectives in Competency Formulation
Position	Study program Expertise Program	Expertise Competence
Job	Vocational Subjects	Subject Competence
Activity	Essential Subjects	Competency Standards
Activities	Essential Sub-Subjects	Basic competency

Figure 3. Analysis of study programs based on the demands of positions at work environment.

Whereas the equality between the structure of positions at work environment and the structure of competencies in vocational expertise programs are as follows:

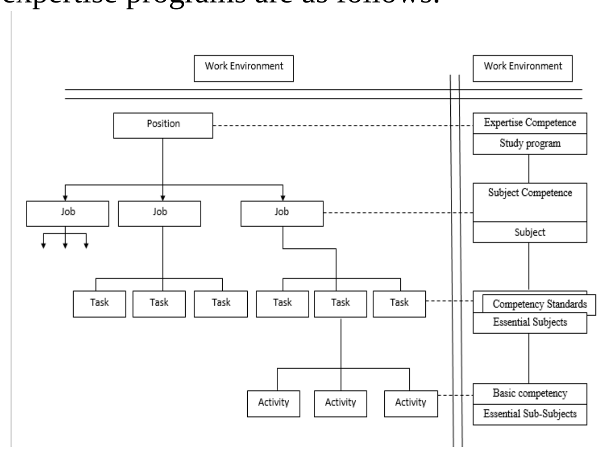

Figure 4. Equality between occupational structures at work environment and ompetency structures in vocational expertise programs.

b. Analyze Relevant Prerequisites

Other sources of prerequisites that are not related to competence are the target work system, target groups and learning content. For this purpose, morphology was changed to a standard sheet that could be used in consultation with relevant stakeholders to develop organizational goals, requirements and conditions for the design of teaching factory frameworks. In this context, the characteristics of individual design elements as part of the system are discussed and determined, the context of the definition of target learning, the overall definition of the desired competencies. The purpose of this step is to identify and formulate the dispositions needed to succeed in overcoming the relevant problem situation.

c. Perform Conceptual Planning And Details.

At this stage, identification of competencies that previously have been carried out and designing didactic concepts - general methodology and technical-social infrastructure.

2. Design factory teaching curriculum management and learning at the macro level. Design factory teaching curriculum management and learning at the micro level is made with the following steps:

a. Determine the general conditions and prerequisites of the learning module and identify the roles discussed in the learning module.
b. Operate learning targets by creating competency transformation tables to operate competencies identified based on requirements using elements of knowledge related to performance and competencies that have been carried out in the previous step.
c. Make technical-methodical designs from the learning module.

The design of the implementation of factory teaching curriculum at the meso level can be visualized in the form of a syllabus for the implementation of the curricum teaching factory. The components that build the syllabus for the implementation of the factory teaching curriculum include the ability to be mastered (indicators), basic competencies (BC) listed in the subject curriculum, class, semester, competency domain (Attitude, Knowledge, Skill), assessment level, form of assessment, legality.

3. Design factory teaching curriculum management and learning at the micro level. Factory teaching design curriculum management and learning at the micro level is carried out by defining frameworks and targets and designing individual learning situations. The design at the micro level is in the context of the learning process with general skills, namely observation and replication of actions, reproduction of tasks from instruction or memory, reliable execution without assistance, adaptation or integration of skills to meet requirements, automatic activity management and not being aware. Visualization of the micro level design is in the learning device which includes the implementation syllabus of each position in the job, position SOP in the job, assignment or occupation in the position, learning material for each position in the job, assessment grid per subject for each position, outcome card study, list of conversion values and activity schedules.

CONCLUSION

From this research, it can be concluded that the design of teaching factory curriculum management and learning at the macro level is done by identifying the conditions of the framework specifically teaching factory, company objectives, organizational prerequisites relating to the learning system. From the results of the identification, an analysis of the relevant prerequisites, conceptual and detailed planning are carried out. The design of factory teaching curriculum management and learning at the messo level is done by determining the general conditions and prerequisites of the learning module, operating the learning targets and making technical-method designs from the learning module.

RECCOMENDATION

While in the factory teaching design curriculum management and learning at the micro level is done by defining the framework, targets and design of individual learning situations as contained in the implementation syllabus of each position in the job, position SOP in jobs, assignments or occupations, learning material in each position in occupation, grading per subject for each position, study result card, list of conversion values and schedule of activities.The design of the teaching factory curriculum and learning

ISSN No. 1978-3787 (Cetak)
ISSN 2615-3505 (Online)

management in this study only focused on vocational secondary schools, researchers can adopt this model to focus other objects such as universities.

REFERENCES

[1] Abele, E., Chryssolouris, G., Sihn, W., Metternich, J., ElMaraghy, H., Seliger, G., … Seifermann, S. (2017). Learning factories for future oriented research and education in manufacturing. CIRP Annals, 66(2), 803–826. doi:10.1016/j.cirp.2017.05.005

[2] Abele, E., Metternich, J., & Tisch, M. (2018). Historical Development, Terminology, and Definition of Learning Factories. Learning Factories, 81–97. doi:10.1007/978-3-319-92261-4_4

[3] Abele, E., Metternich, J., & Tisch, M. (2018). Overview on the Content of Existing Learning Factories. Learning Factories, 263–287. doi:10.1007/978-3-319-92261-4_8

[4] Abele, E., Metternich, J., & Tisch, M. (2019). Learning Factories. doi:10.1007/978-3-319-92261-4

[5] Abele, E., Metternich, J., Tisch, M., Chryssolouris, G., Sihn, W., ElMaraghy, H., … Ranz, F. (2015). Learning Factories for Research, Education, and Training. Procedia CIRP, 32, 1–6. doi:10.1016/j.procir.2015.02.187

[6] Andreas Jaeger, et.al., 2011, *The "Learning Factory": An immersive learning environment for comprehensive and lasting education in industrial engineering*, Vienna: Institute for Management Science, Vienna University of Technology.

[7] Cachay, J., Wennemer, J., Abele, E., & Tenberg, R. (2012). Study on Action-Oriented Learning with a Learning Factory Approach. Procedia - Social and Behavioral Sciences, 55, 1144–1153. doi:10.1016/j.sbspro.2012.09.608

[8] Chryssolouris, G., Mavrikios, D., & Mourtzis, D. (2013). Manufacturing Systems: Skills & Competencies for the Future. Procedia CIRP, 7, 17–24. doi:10.1016/j.procir.2013.05.004

[9] Chryssolouris, G., Mavrikios, D., & Rentzos, L. (2016). The Teaching Factory: A Manufacturing Education Paradigm. Procedia CIRP, 57, 44–48. doi:10.1016/j.procir.2016.11.009

[10] Clive Dimmock & Helen Wildy (1995) Conceptualizing curriculum management in an effective secondary school: a Western Australian case study, The Curriculum Journal, 6:3, 297-323, DOI: 10.1080/0958517950060303

[11] College of Business, 2015, Curriculum Management HandBook, University of Central Arkansas (UCA).

[12] Direktorat Pembinaan Sekolah Menengah Kejuruan, 2017, *Tatakelola Pelaksanaan Teaching Factory*, Jakarta: KEMENDIKBUD.

[13] Education Department Hong Kong, 2001, *Performance Indicators (Pre-primary Institutions) Domain on Learning and Teaching, Second Edition*, Wanchai, Hong Kong: Social Welfare Department

[14] G. Chryssolouris, D. Mavrikios, L. Rentzos, 2014, *On a new educational paradigm for manufacturing: The Teaching Factory*, University of Patras, Greece.

[15] G. Chryssolourisa, D. Mavrikios, L. Rentzos, 2016, *The Teaching Factory: A Manufacturing Education Paradigm*, Published by Elsevier, 49th CIRP Conference on Manufacturing Systems (CIRP-CMS 2016).

[16] George Chryssolouris, 2015, *The European Teaching Factory Paradigm*, Greece: University of Patras.

[17] Kurangi, Nanjwade and Jangade, 2017, Education Methodology: Curriculum Management, *World Journal of Pharmacy and Pharmaceutical Sciences*,

Volume 6, Issue 2, 1385-1396, ISSN 2278 – 4357

[18] Lumadi, M.W., (2014) Factors Confronting Transformational Leadership: A Curriculum Management Perspective, International Journal of Educational Sciences, 7:3, 663-672, DOI: 10.1080/09751122.2014.11890229.

[19] Rentzos L.a, et.al., 2014, *Integrating Manufacturing Education with Industrial Practice using Teaching Factory Paradigm: A Construction Equipment Application*, Variety Management in Manufacturing. Proceedings of the 47th CIRP Conference on Manufacturing Systems.

[20] Rentzos, L., Doukas, M., Mavrikios, D., Mourtzis, D., & Chryssolouris, G. (2014). Integrating Manufacturing Education with Industrial Practice Using Teaching Factory Paradigm: A Construction Equipment Application. Procedia CIRP, 17, 189–194. doi:10.1016/j.procir.2014.01.126

[21] Subekti and Ana, 2018, *Measurement of Employability Skills on Teaching Factory Learning*, IOP Conference Series: Materials Science and Engineering.

[22] Tally Hatzakis1, Mark Lycett2 and Alan Serrano2, 2007, A programme management approach for ensuring curriculum coherence in IS (higher) education, European Journal of Information Systems (2007) 16, 643–657. doi:10.1057/palgrave.ejis.3000707

[23] Tisch, M., Abele, E., & Metternich, J. (2018). Overview on Potentials and Limitations of Existing Learning Factory Concept Variations. Learning Factories, 289–321. doi:10.1007/978-3-319-92261-4_9

[24] Tisch, M., Abele, E., & Metternich, J. (2018). The Life Cycle of Learning Factories for Competency Development. Learning Factories, 127–198. doi:10.1007/978-3-319-92261-4_6

[25] Tisch, M., Abele, E., & Metternich, J. (2018). The Variety of Learning Factory Concepts. Learning Factories, 99–125. doi:10.1007/978-3-319-92261-4_5

[26] Tisch, M., Hertle, C., Abele, E., Metternich, J., & Tenberg, R. (2015). Learning factory design: a competency-oriented approach integrating three design levels. International Journal of Computer Integrated Manufacturing, 29(12), 1355–1375. doi:10.1080/0951192x.2015.1033017

[27] Tisch, M., Hertle, C., Abele, E., Metternich, J., & Tenberg, R. (2015). Learning factory design: a competency-oriented approach integrating three design levels. International Journal of Computer Integrated Manufacturing, 29(12), 1355–1375. doi:10.1080/0951192x.2015.1033017

[28] Tisch, M., Hertle, C., Abele, E., Metternich, J., & Tenberg, R. (2015). Learning factory design: a competency-oriented approach integrating three design levels. International Journal of Computer Integrated Manufacturing, 29(12), 1355–1375. doi:10.1080/0951192x.2015.1033017

[29] Tisch, M., Hertle, C., Cachay, J., Abele, E., Metternich, J., & Tenberg, R. (2013). A Systematic Approach on Developing Action-oriented, Competency-based Learning Factories. Procedia CIRP, 7, 580–585. doi:10.1016/j.procir.2013.06.036

[30] Yuen Ling Li (2001) Curriculum management and classroom practice in kindergartens in Hong Kong, Education 3-13: International Journal of Primary, Elementary and Early Years Education, 29:1, 56-61, DOI: 10.1080/03004270185200111

ISSN No. 1978-3787 (Cetak)
ISSN 2615-3505 (Online)

HALAMAN INI SENGAJA DIKOSONGKAN