

Developing Instructional Model for the Vocational Competence in CNC Machining for Vocational High School Students

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Abstract

This study aimed to: (1) produce a model of learning for CNC machining subjects for Vocational High Schools (VHSs) in accordance with the standards of competence and basic competences, and (2) analyze the feasibility and effectiveness of *Best CNC* learning models for the formation of the vocational competence in CNC machining for VHS students.

This study employed the research and development approach. The research procedure was the design and development research by Richey and Klein consisting of two stages of development, i.e.: (1) a comprehensive model development, and (2) a process of developing model components. The model validation process consisted of two stages, i.e. the internal validation and the external validation. The internal validation was carried out on the model components through peer reviews and a focus group discussion and the external validation was conducted through a pilot test. The validation process involved 24 participants consisting of: experts in the CNC machining subject, vocational education experts, a workshop management expert, VHS teachers, and VHS students. The research method employed in the pilot test was the qualitative and quantitative descriptive methods.

The results of the study are as follows: (1) A learning model for CNC machining has been produced and the name of the model is *Best CNC* that has components: learning modules, utilities used, and evaluation instruments. (2) *Best CNC* learning model can be applied and effective in forming students' competence including the settings of CNC machines, CNC machine programming and CNC machines operation. All students have mastered each competency standards after using this learning model. *Best CNC* learning model is more efficient and effective than those applied in VHSs at present.

Keywords: Learning Model, vocational, CNC, VHS

Introduction

Some new subjects in the vocational curriculum appears to follow the development of the era. Advances in computer technology and the industry has a lot to change the capabilities and skills in machining competency of job seekers especially for former students of VHS. Conventional machine tools which were originally used by most industries in the seventies, has now been replaced with a machine tool controlled by a computer because of high productivity and accuracy. The machine is the CNC (Computer Numerically Controlled) machine tools, that are controlled by a computer program through a system of numerical control. In the

current technology in manufacturing is growing very rapidly, so a lot of CNC machines used in the machining industry to produce parts with a high level of complexity and precision (Subagio and Atmaja, 2011:105). According to Mike Lynch (<http://www.cncci.com/resources/articles/CNCmanual.htm>) at this time more than 80% of companies that make various kinds of products have at least one CNC machine. In response to these conditions, the VHS was challenged to prepare students to be competent enough to work, through learning to meet the needs of the workforce and industry.

Training to operators of CNC machine tools include the settings, operate, and monitor the process. Skills of planning, controlling, programming, and CNC machine settings should be taught to trainees (<http://www.siemens.com/cnc4you>). Thus the implementation of the learning process of CNC machining competence are more likely in of the procedure knowledge skills than the manual skills. Berner (2008:177) analyzes that have been ongoing changes of the learning process in terms of knowledge, social, and emotional to be a machine tool operator. Matter and how students learn will be part of their own self-understanding, identity work in the future, and feelings about something he knows. Employment in manufacturing companies that use CNC machines are handled by the engineers, programmers, and operators (Bureau of Labor Statistics, 2010). Engineer in charge of the field of CNC machinery to plan and create software. CNC programmers tasked to create a CNC program is based on the working drawings designed by the designer. CNC machine operator to set the machine and its peripherals, include the program on the machine, the setting of cutting tool, workpiece set up, run the CNC program to create a product, and do the machining process measurement products. CNC machine operator is a person who needs to know how to run a CNC machine is not planning or designing a CNC program (<http://www.amatrol.com/programs>).

Based on field observations, a model of learning for subjects to most of CNC machining at vocational schools are refer to the CNC machine, teaching materials, teaching methods, learning strategies and learning approaches made by EMCO, companies from Austria, developed in the 90 's . This can be seen from the learning module and electronics books which is used in vocational schools published by the Directorate of SMK on the Internet (<http://www.ditpsmk.org>). Based on the above facts, it is necessary for effective and efficient learning models to establish a

vocational student competency in accordance with the standards of competence and basic competence.

Literature Review

Many experts put forward a definition of a model of learning and developing learning models. Models of Teaching is in fact also be regarded as models of learning (Joyce et al, 2009: 7). Gunter in Santyasa (2007:7) defines learning model as follows: "an instructional models is a step- by- step procedure that leads to specific learning outcomes." Joyce, et al (2009:30) said: " A model of teaching is the idea of a learning environment that also includes our behavior as a teacher when the model is applied. "A more detailed description set forth in the other website (<http://www.edtech.vt.edu/edtech/id/models/>), which is " teaching models prescribe tested steps and procedures to effectively generate desired outcomes. In general, models can be classified along a continuum from instructor -directed, instructor to student - negotiated, to student -directed. "

Joyce, et al (2009:31-45) classify learning model into four major groups, namely: (1) the information processing model of learning, (2) the social learning model, (3) the model of personal learning, and (4) group learning model of system behavior. Each group consists of many models of teaching or learning model. The models of information processing group consists of: inductive thinking, concept discovery, inductive word-pictures, scientific research, research training, mnemonics, sinektik, and advance organizers. The group consists of models of social learning model: study partner - positive independence, organized research, investigation groups, role playing, and jurisprudential research. Group personal learning model consists of model: teaching without direction, and improve self-esteem. The group consists of models of learning behavior model: learning to master, direct instruction, simulation, social learning, and the planned schedule.

McIlrath and Huitt (1995) defined "A model is a visual aid or the picture which highlights the main ideas and variables in a process or system". Models in particular discusses the model as measured by standardized test scores for the basic science subjects (basic skills) are: reading, language arts, mathematics, science, and social studies. These models are: John Carroll, Proctor, Cruickshank, Gage and Berliner, Huitt, and Laosa models. The models are used in the United States for the benefit of an increase in basic skills.

Based on the above descriptions it is understood that the learning models (models of teaching) has a broader meaning than the methods, strategies/approaches, and procedures. Learning model based on learning objectives to be achieved, the skills students will be obtained, and the learning environment is used. Thus to construct a model of learning for learning purposes (competency) must be specified in advance the philosophy underlying the competencies to be taught, learning theories that support, learning competencies to be achieved (cognitive, psychomotor, or affective), and the theory of the subjects or teaching materials concerned.

CNC machining competencies for vocational students is the student's ability to cover aspects of knowledge, skills and attitudes in the use of CNC machines to make things work according to the standards of competence and basic competences (*SKKD=Standar Kompetensi dan Kompetensi Dasar*). Competencies to be possessed by vocational students are setting, programming, and operating the CNC machine tool. Basic competency to be controlled in large part on the cognitive (ie operational work: describe and recognize) and psychomotor domains (with the verb operations: install, perform, instruct, change, write, implement, test, operate, and monitor). Attitude formation is not implied in the competency standards, but is written in Basic Vocational Competencies, namely to apply occupational safety and health, with descriptions of basic competencies and implement health and safety procedures.

According to Drake (2007: 2), the standard of competency -based learning approach, teachers are expected to prepare students to meet the standards of accountability within the framework of the learning process. The curriculum is taught is the same for the same level throughout the country. Students must follow the standardized competency exams to demonstrate that the student has achieved a certain level of success. The results of the competency test is used as an indication of the level of student learning. Further noted also that the competency -based teaching approaches adopted the following principles: (1) the planning process with the design -down curriculum, (2) focuses on what students will do, not what the teacher will teach, (3) standards of competence, teaching strategy and assessment of neatly arranged, (4) is very important to decide what should be known, worked and served the students, (5) standards of competence can be observed and measured, (6) assessment of competency standards to be used as a learning strategy; (7)

understanding of complex ideas and serves as an umbrella of course content; (8) the performance of complex skills always comes up every year and on all subjects; (9) the content of lessons as a means to achieve competency standards, and (10) teachers -free teach with all kinds of styles of teaching for competency standards are met.

Methodology

Stages of research using the stages of design and development research by Richey and Klein. According to Richey and Klein (2007: 8) design and development of research consists of two main categories: (1) product and research tool, and (2) model research. Research on the category of product development stages are: analysis, planning (design), development, and evaluation. While basically the same development tools with product development but are also more emphasis on: (1) development tool , and (2) tool use. The research phase of the model include: (1) development model, (2) validation of the model, or (3) use of the model.

Model Development

The process used in this study is the modeling study by Richey and Klein (2007: 65). Step -by-step development of such models in detail include: (1) development model, (2) model validation, and or (3) try out the model. On the development of this model there are two kinds of development are: (1) the development of comprehensive models, and (2) the development of model components.

Before carrying out the development is preceded by a preliminary study to find a model that is currently applied by the study subjects as material to develop a learning model of CNC machining. Model validation process is carried out two kinds of internal validation and external validation. Internal validation performed on the components of the model, while the external validation studies the impact of the model. External validation of the model is done by a pilot test or try out on the subject of the research. Try out conducted in small groups of students at one location. A try out was made to the number of students in accordance with the provisions of the model, which is eight students. Try out conducted in the CNC laboratory in accordance with the provisions of the Best CNC model (Figure 1).

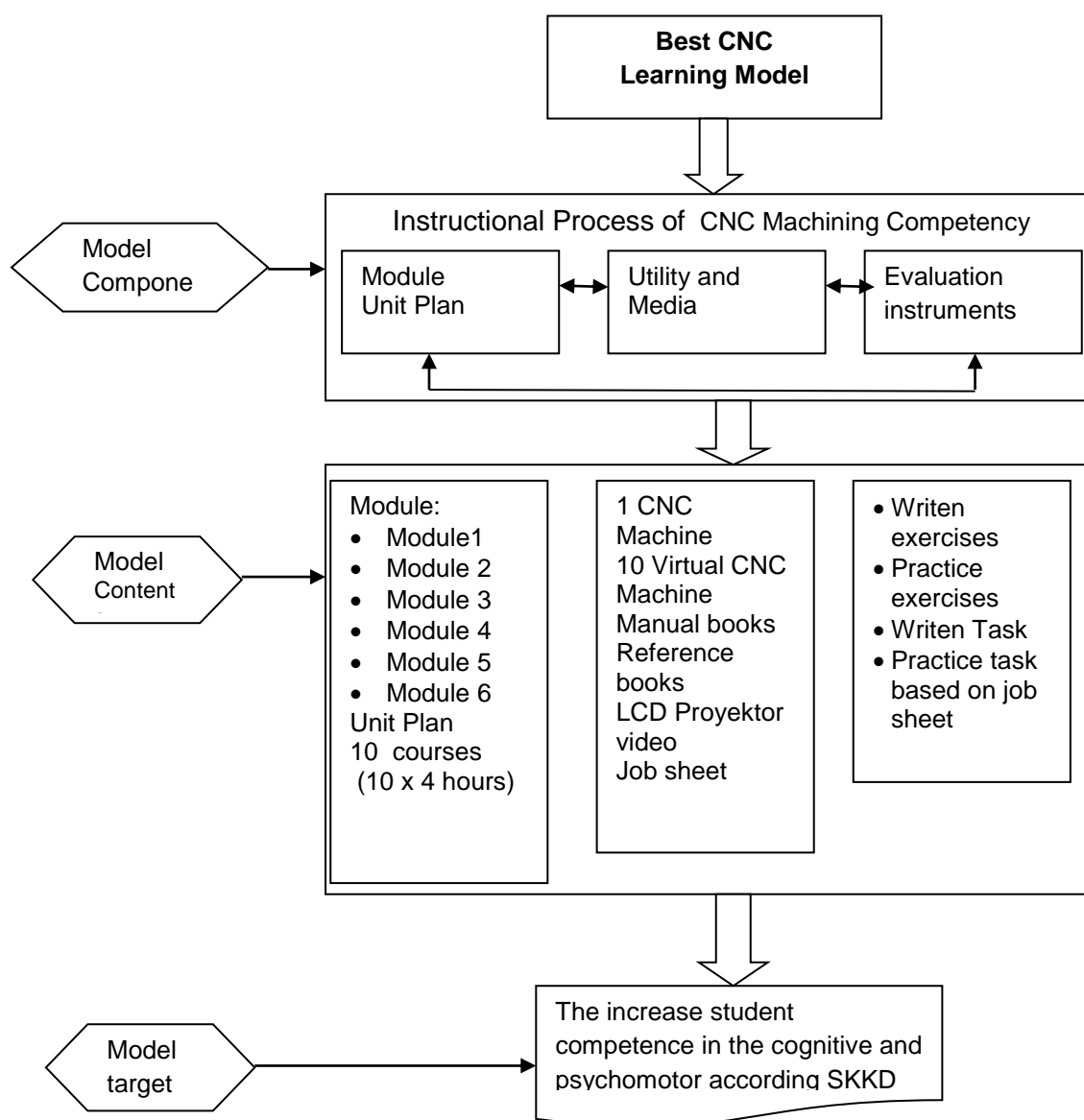


Figure 1. *Best CNC Learning Model*

Try out Result

Try out the use of learning models implemented at one school site which already has a utilities of CNC machining course in accordance with the learning model developed. Try out is conducted in 10 meetings. Each class meeting held for 4 hours of lessons. The course process is in Figure 2.

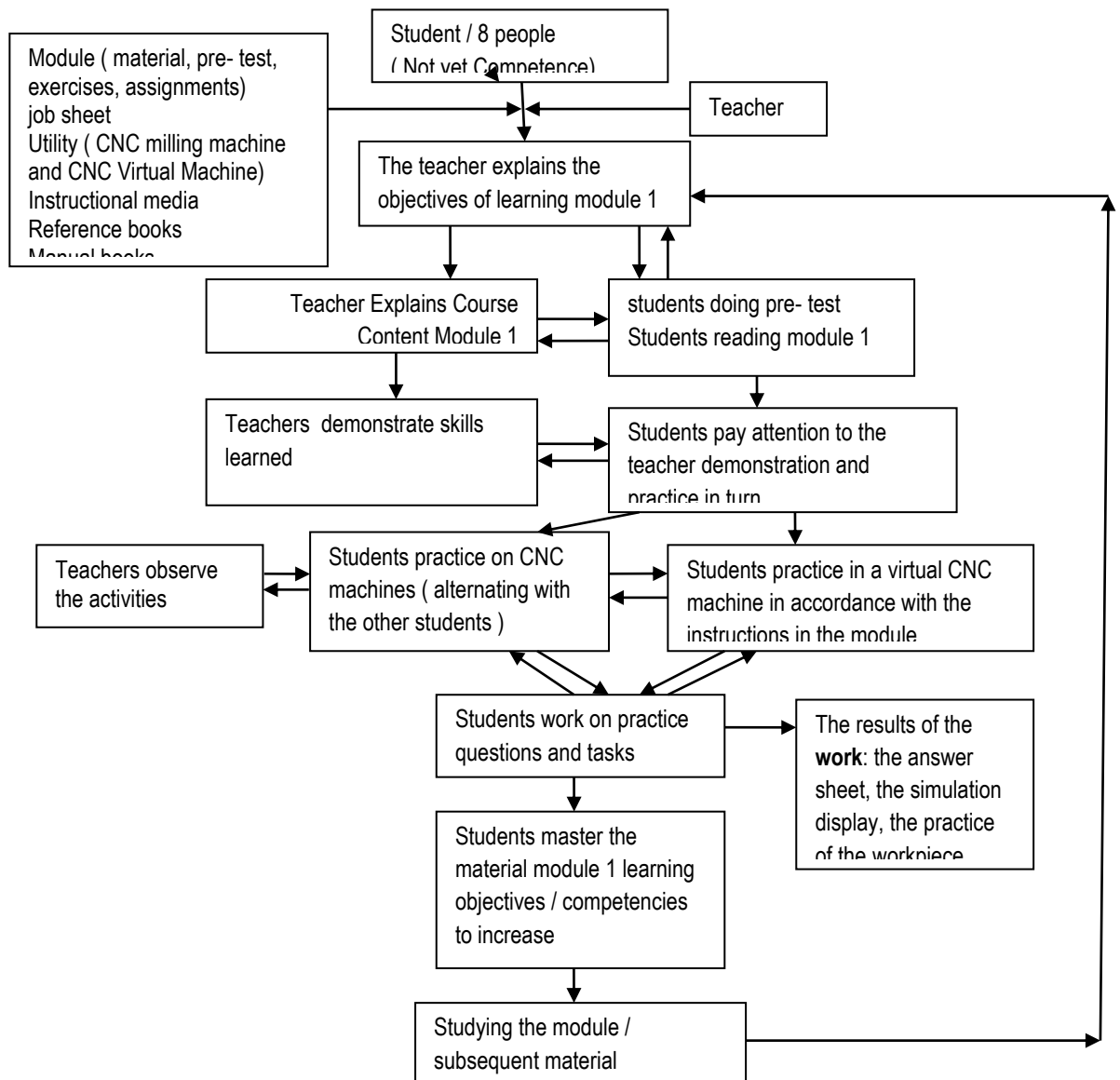


Figure 2. Course process of the try out

Improvement of students competency

During pilot testing, the competencies achieved by students are observed by teachers and researchers. Achievement of competency standards were observed using performance indicators, amounting to 90 performance indicators. The increase of student competence can be seen in Figure 3.

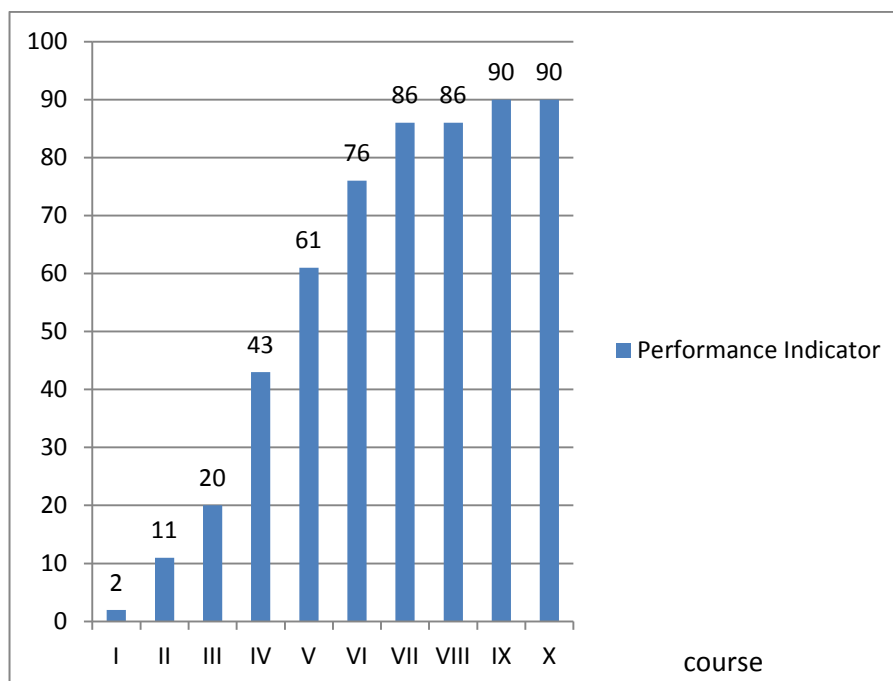


Figure 3. The improvement of students competency

All students stated that the Best CNC learning model is an interesting model of learning, the learning module can help the learning process, and students have been convinced to operate the CNC milling machine and virtual CNC milling machines. Best CNC learning models purpose are improving the competence of students, so that in the opinion of students on the above description it can be said that the purpose of these models has been achieved. Recap student opinion on the Best CNC learning model can be seen in Table 1.

Table 1.
Opinions from The Students Regarding Best CNC Learning Model

Student opinion	Percentage of Answers
1. Interesting learning model	100%
2. Understanding of learning material	
a. Understand the learning material completely	50%
b. Understand the most of the learning material	50%
3. Questions and tasks	
a. Very adequate to establish the competence	75%
b. Adequate to establish the competence	25%
4. Questions and tasks actually measure the knowledge and skills	100%
5. Get direct feedback	100%
6. Been able to operate a CNC milling machine	100%
7. Been able to operate the virtual CNC milling machine	100%

Competencies that students can independently operate CNC machines are the demands of competency standards in accordance with SKKD. Competence is essentially a student's ability to include competencies in the domain of affective, cognitive and psychomotor skills. This model is in trials do not measure students' affective competencies, but from the implementation of the trial shows that students carry out the learning process seriously, maintaining workplace safety, maintain the safety of the machine, maintain the safety of other students, and always tried to follow the steps modules are written in earnest. Look in cognitive abilities of students have been able to do practice questions and tasks that can improve cognitive abilities. Skills of the students looked up, the ability to check the results of all students claimed not to operate a CNC machine and after learning to use the model to follow the Best CNC states are sure all students can operate the CNC machine. Thus it can be said that the Best learning model CNC has proven effective in shaping students' competency in CNC machining.

Teachers who implement the Best learning model CNC feel that the modules, software, and learning steps suggested by CNC Best models was helpfully. In the implementation of learning for the next semester the teacher will use this learning model, it is because: a learning tool in the form of CNC machines and computers, learning modules, practice materials, and teaching schedule allows for the implementation.

Feedback from teachers is that teaching materials in the module coupled to the material with other control systems are a valuable input. These suggestions will be met by developing learning modules with GSK or Fanuc control system and still use the concept of learning models and frameworks of the Best CNC. Changes will be made on the content of the modules, especially regarding the description of the control panel, programming code, setting the zero point, and operation of CNC machines. Solved exercises and assignments, and job sheet is still being used.

Conclusions

Based on this research, the conclusions in this study are:

- 1) *Best CNC* learning model efficient in shaping students' competence in accordance with the demands of competency -based curriculum. Use of facilities and time

spent learning to use a learning model *Best CNC* less than the current model of applied learning in the vocational high schools.

- 2) *Best CNC* learning models effective in shaping students' competence in accordance with the demands of competency -based curriculum. Three standards of competence can be achieved by the students after participating in learning by using *Best CNC* models are more than the use of learning models currently used by VHS.

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