



## **The teaching of mechatronics in Luban Workshop with EPIP teaching model; practice and assessment**

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**Abstract:** The purpose of the article is to introduce the Engineering Practice Innovation Project (EPIP) teaching model in Luban Workshop platform and to show its implementation for teaching of mechatronics technology application in cultivating students to be competent at local and international skill contest. The teaching model of Engineering Practice Innovation Project (EPIP) and Luban Workshop has been founded on the educational thoughts of ancient and modern Chinese and its scholars that emphasized the combination of hand and brain in skill training. A training of mechatronics technology application was carried out using EPIP teaching model in a Luban Workshop arrangement. The training was student centered that promote team work and cooperative training. It was flexible project-based training with continuous and formative assessment with enabling trainees to participate and won local and international talent/skill contest as its achievement. A training assessment was conducted. The trainers indicated that the training was project-based that encouraged trainees' participation, interaction, group/team work, innovativeness and creativity that enable them to be competent in the international skill contest. The trainees also indicated that they learnt new skills and that the training impacted their future carrier in the profession with changing their practice habit profoundly and inducing craftsman sprit.

**Key words:** EPIP teaching model, Luban Workshop, engineering education, vocational education

### **1. Introduction**

Many countries, schools and universities has made many reforms in teaching engineering courses based on different model of teachings. There are different and related models of teaching and training of engineering and vocational educations in all level of educational systems naming mastery learning, outcome-based education (OBE), and Conceiving - Designing - Implementing - Operating (CDIO) which are developed and implemented in many countries.

According to Spady (1994) outcome-based education (OBE) direct and organize everything in an educational system based on what is indispensable for all trainees to be able to do efficiently at the at the conclusion of their learning experiences. This means starting with visualizing of what is important for pupils to be able to perform at the end, then arranging curriculum, instruction, and assessment to bound to the desired learning outcome achieved. The essential things in outcome-based system are: setting a clear set of learning outcomes around which all of the

system's components can be focused; creating the circumstances and prospects within the system that enable and inspire all students to achieve those essential outcomes.

OBE teaching model highlights the capabilities that students should have when they join the workforce. For example, ABET accreditation system of American engineering education has articulated 11 abilities or learning outcomes for engineering graduates. Therefore, the teaching and learning activities should emphasize the realization of these specified learning outcomes by making students to actively engaged in the teaching and learning activities (Felder & Brent, 2003).

CDIO is an international initiative for reforming engineering education which is developed initially by collaboration of universities from Sweden and USA in 2000 (Berggren & et al., 2003). The goal of the initiative is to cultivate students to achieve a deep working knowledge of technical fundamentals which lead them to innovate and operate new products and systems (ibid). To attain this the initiative has four constituent parts: curricular reform, methodological improvement, creating experiential learning environments and efficient assessment method (Bankel et al., 2008).

For the past 150 years China was absorbing technology and educational ideas from abroad without outputting to the world. Along with these years China's vocational education has developed to a highest level being one of the driving gears for Chinese successful growth and economic development. In the beginning and mid of 2010s China has started sharing the achievement of its vocational education to the world using Luban Workshop as a platform for sharing the EPIP teaching model and the latest technical equipment by opening the first Luban Workshop in Thailand on March 8<sup>th</sup>, 2016. Since then, China has built 18 Luban Workshops in 17 countries thorough out the world out of which 11 workshops were built in Africa. EPIP teaching model was developed based on the ancient and modern wisdom of Chines, international advancing teaching theories, and decades of experience in teaching and theoretical research by a team of experts lead by Lyu Jingquan<sup>1</sup>. In parallel with building Luban Workshops Chines universities and industries has trained foreign teachers in Luban Workshops in China focusing on hands-on practice ability and enabling the trainees to compete at international level which was appreciated by foreign teachers and students.

The purpose of this article is to give an overview the application of EPIP teaching model and Luban Workshop for the teaching of mechatronics technology application. Tianjin University of Technology arranged the Luban Workshop platform to train seven trainees from Ethiopia Technical University for six months. It gave a brief overview of EPIP teaching model, Luban Workshop, and the specific methods applied for teaching mechatronics. Investigate and report whether the teaching model has achieved its objective of enabling the trainees to be competent in local or international talent contest.

## **2. EPIP Teaching Model**

### **2.1.Foundation**

The Teaching model of Engineering Practice Innovation Project (EPIP) and Luban Workshop has been founded on the educational thoughts of ancient and modern Chinese and its scholars of

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<sup>1</sup> Lyu Jingquan is the think-tank of EPIP and Luban Workshop, and also the author of the two books: Key Principles of Luban Workshop and Teaching Modell of EPIP

Mozi<sup>2</sup>, Luban<sup>3</sup>, Huang Yanpei<sup>4</sup>, and Tao Xingzhi<sup>5</sup> that emphasized the combination of hand and brain in skill training.

From around 500 BC, the thought of Mozi (Mohism) with universal love and virtue complemented with his contemporary wisdom of Luban that emphasize practical work and courage is the ancient heritage of Chinese culture.

Among the modern educators of China especially in what and how should be the theory and practice of vocational education, Huang Yanpei, who is pragmatist in vocational education development, was the premier. He advocated that in order to realize a great vocational education system, it is compulsory to go beyond the small circle of vocational institution by cooperating and communicating with the wider circle of society. He promoted that vocational education should allow the overall wellbeing of the individual and the society at large and provide competent individuals to address the productivity requirement at national and international level. He strongly advised that vocational education should combine hand with brain, augment learning with practice, and integrate theories with practice and knowledge with skill.

Tao Xingzhi is a guru in education in present day China. His masterpiece in education is a complete set of education theory and practice. According to his masterpiece education should be aimed not to mold an individual for a specific purpose for certain advantage but it should aim at developing an all-round person. He also dictated that the relationship between teacher and student should be that the teacher shouldn't teach merely but teaches the student to learn.

Based on the ancient and modern wisdom of Chines, decades of experience in teaching and theoretical research, and international advancing teaching theories, a team of experts lead by Lyu Jingquan come up with an innovative model of teaching for vocational education called EPIP teaching model.

EPIP is an acronym of Engineering, Practice, Innovative, and Project. The acronym terms tried to convey the concept and principles of the teaching model. Having engineering to solve the real-world problem the teaching model emphasized that teaching and the knowledge gained should be from practice as the Mozi stressed. This entails and necessitate the cooperation of schools and industry. The teaching should promote innovativeness and should be based on project.

## **2.2.Meaning of EPIP**

China has built comparatively the largest scale technical and vocational education (TVET) in the world with near to 50% enrollment in vocational education compared to general education both at secondary and higher education level. So, improving the delivery of vocational education with a clear purpose of training high quality technical talents is vital for the nation development. To address this concern a team of experts lead by Lyu Jingquan has developed EPIP teaching model having the foundation of ancient and modern Chinese educational wisdom combined with

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<sup>2</sup> Mozi (c 476-480 B.C or 390-420 B.C) was born in the Song Nation at the end of the Spring and Autumn period. He was a thinker, educator, scientist, strategist, and founder of the Mohist school and established scientific theories in geometry, physics and optics

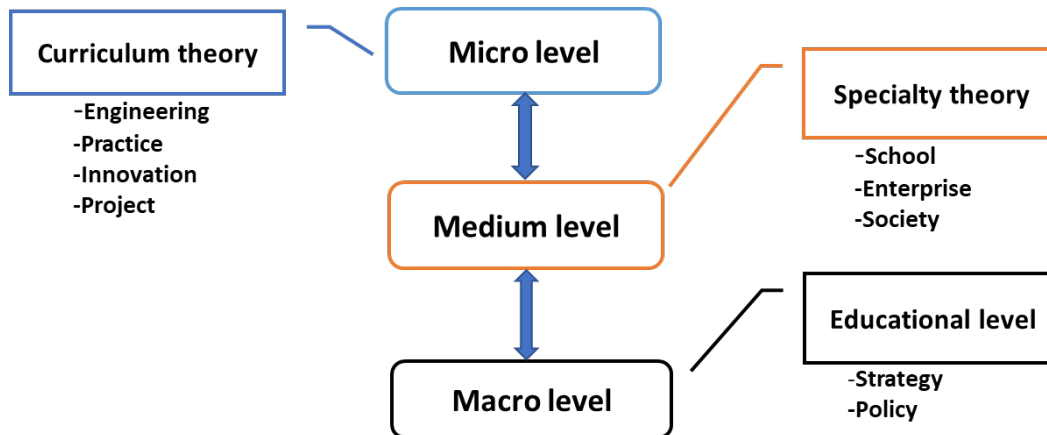
<sup>3</sup> Lu Ban (c 507-444 B.C) was a structural engineer, inventor and carpenter during Zhou dynasty. He is regarded as a master crafts man by Chinese people having craftsman soul.

<sup>4</sup> Huang Yanpei (1878-1965) was educator and reformer, writer and politician

<sup>5</sup> Tao Xingzhi (1891-1946) was a famous educator and reformer.

international advanced educational thoughts and experience. EPIP teaching model is key in achieving the reform needed in vocational education in China.

EPIP has three layers of models in its structure. From top to bottom it is: micro level (curriculum theory), medium level (major/specialty theory), and macro level (education theory) as shown in Figure 1.



**Figure 1:** Structure of EPIP

The micro level of EPIP is the focus of the curriculum and its implementation. It was detailed on meaning of the terms that constitute EPIP: Engineering, Practice, Innovation and Project. The ‘Engineering’ of EPIP has carried the meaning that EPIP is up to solving the real-world problem or situation. Thus, the curriculum development, content selection, teaching methods, evaluations and implementation should be aimed at solving real-world problem and adapted to the real-world situation and be realistic in its entirety.

The “Practice” of EPIP indicate that engineering should be a practice otherwise its nothing. In the teaching reform of EPIP the practicality of engineering projects and cooperation with the relevant industry are essentials. The teaching and its evaluation should be practice based. Competition of practical talent in line with industry requirements at local and national level in design, installation, fault finding and maintenance of engineering projects is the pillar of EPIP. Engineering directed by practice with creating real condition for practice by adopting real competition equipment from the industry and that improve the skill application standard is the teaching model of EPIP. The teaching model also give focus on practicing teamwork and improving professional quality as tasks of projects and also competition is accomplished in team with professional quality. ‘Practice makes perfect’ is its motto.

EPIP model of teaching promote innovativeness. The term “Innovation” of EPIP is an indication that innovation is one of its pillars. With the real-world situation and problem as a background and having abundant engineering knowledge and practice leads to innovation.

The “Project” of EPIP make the “Engineering”, “Practice” and “Innovative” of EPIP complete. The teaching and training should be project based developed from simple to complex, shallow to deep level as students getting more and more experiences from the whole procedures and steps of accomplished projects. Students should own the project from conception to the final outcome. In the process the role of the teacher shall be guidance by sharing information at all level of the project. Teacher should promote students to expand their projects further by improving the techniques, design, technology and task accomplishment performance to achieve additional

goals. This avoids fragmented education and rather make complete. Project-based education encourage and promotes 'cognitive competence, ability for independent thinking, logical reasoning, information processing, cooperation, self-control and team-working, innovativeness, curiosity, and imagination' of students.

The medium level under EPIP teaching model focused on major, specialty, occupational and professional development through the integration of school, enterprise and society. Vocational institutions should intensely comprehend the competency requirements of various enterprises and their professional demands so as to specify the professional technology that students equipped with and the qualification that students attained.

The macro education level of EPIP teaching model command the need of the integration of school and enterprise at policy level to realize the full achievement EPIP at all levels and their constituents of EPIP in its entirety.

China has been realizing the EPIP teaching model using Luban Workshop in its secondary and higher vocation institutions and also is sharing the accumulated knowledge, practice and experience of Chinese vocational education to the world through Luban workshop.

### **3. Luban Workshop**

Luban workshop is an international brand of vocational education of China. It's a cooperative institution for sharing the vast experience of China in vocational education to the world. Being as a platform for sharing EPIP teaching model, professional criterion, high-end technical equipment, training resource and manpower training with the world to produce local talent in cooperative countries for Chinese overseas companies, the primary goal of Luban Workshop is to actualize the Belt and Road Initiative of China. Aside from the cooperative goal of Luban Workshop this paper focus on technical nature and academical features of Luban Workshop in vocational education training.

Luban Workshop is the embodiment of EPIP teaching model for vocational education in cultivating talents required by local and international competent enterprises and industries. In Luban workshop training is carried out using high-quality competition equipment used in the international skill contest such as WorldSkills®.

Luban Workshop named after the ancient craftsman of China called Lu Ban (Luban). Luban was the pioneer in inventing many production and finishing hand tools used by carpenters such as drills, planers, shovels, curved rulers and ink buckets which came out through repeated practice and experiment. He was influenced by Mozi's school of thought of his time. Mozi attached great importance to practice in education and he prioritized that knowledge gained by practice is the basis of all knowledge. Mozi advocate teaching human with great care, teaching by setting oneself as an example, and by taking into account students' aptitude. Luban workshop and Chinese people inherited the exquisite and meticulous skills of Luban and Mozi's wisdom. Craftsman spirit is the core characteristics of Luban wisdom and thus the intention Luban workshop to influence the students to have it.

The wisdom of Luban in accomplishing things is to have rules regulations and standards, then measure accordingly in different ways, use wisdom and cleverness to develop ways of doing things, improving in all ways and continuously until achieving integration of hand with tools and hand with brain. The outcome of these are innovations which benefit the world and human kind

by building a community of shared value. The aim of Luban workshop is inducing craftsmanship. Cultivating students with working spirit, working attitude, quality awareness and moral quality.

#### **4. The teaching of mechatronics**

In this section the training of mechatronics technology application was carried out using EPIP teaching model in a Luban Workshop arrangement was discussed and some points in its implementation were raised. The teaching has contents of theoretical overviews of mechatronics and assembly, programming and commissioning of advanced electropneumatic systems: stack magazine, feeding unit, detection and sorting unit, detection and overturning unit, and electric manipulator unit.

The teaching of mechatronics based on EPIP model in Luban Workshop is student centered. The teachers facilitate the teaching learning process by motivating students to work and solve problems by themselves. The workshop arranged in a way that allow students to do tasks or jobs with the same result but different methods and with the optimal method possible they found convenient.

The workshop promotes team work and allows student to share experience and knowledge with students in other schools and universities which are expertise or center for a certain skill. It gives students to observe and notice the meticulous skill of those students who excel them in order to motivate students to do the same and so better. In agreement with these, teachers and the arrangement of the workshop promote students to practice in workshops with their own extra time and on their time schedule also. The philosophy behind this is empowering students their learning and training.

Teaching in EPIP model in Luban workshop is not conducted only in school or institute. Its cooperative training that allows students to train and practice in industries and enterprises. The training also conducted in cooperation with another university and an industry around the university.

The training specific contents and methods are flexible. Students consulting with their tutor selects their daily area of practice according to their need. Students practice in sole to get the skill they need specific to their need. They also work in team to accomplish a larger project. They asked each other and cooperate doing tasks. The supervisor oversees the general flow of the training and observe the skills demonstrated by the trainees in daily basis in each training session.

Project-based/learning or training (PBL) is easily adapted to address the goal of Luban workshop to train students to solve real world problems, be innovative and be competent in local and international skill contest. PBL is highly recommended by many education experts, studies and researches as instructional methods.

EPIP training system in Luban Workshop implement continuous and formative assessments. As a continuous assessment students accomplish tasks daily and submit their accomplishment to their supervisor so enable the supervisor understand their status and give directions and recommendations accordingly. In EPIP teaching model assessment students should demonstrate mastery learning or mastering tasks and jobs accomplishment according to a criterion set.

One key and wonderful way of assessing student progress and achieving in EPIP model of teaching is enabling students to participate in local and international talent contest. At the end of

the training trainees participated on international competition and a good achievement was recorded

There are few studies about the implementation of EPIP. Li (2019) suggested some points on the implementation of EPIP teaching model. He first suggested the necessity of reforming the traditional training model to EPIP talent training which focuses on student's practical ability in order to foster high-quality and all-round talents. And also suggested that EPIP model suitable for all type of students at all age for general education as well as short term training in various fields. In related to Luban workshop arrangement and management, he suggested that the workshop should be equipped in a manner that allow teachers and students to work conveniently including on their own time to boost practical ability and innovativeness. There is no a fixed Luban workshop layout but the arrangement is flexible based on the projects students carried out as each project has different aspects of knowledge, skill training and equipment requirement, and also students may have different majors and competency level and training requirement. The training is carried out first by covering the traditional mechatronics courses mechanics, electricity, computer and control. Then integrating the traditional courses with professional course such team work and communication. The content of the EPIP based curriculum adopts project-based model with each project focusing on different knowledge and skills and that emphasize practice and innovation. Students are arranged in group with three members to form an engineering team with the teacher playing a coordinating or mentoring role. The EPIP-based curriculum adopts a process-oriented evaluation and project final report that indicate every item of the project process and result.

The implementation of EPIP strongly required a regular based further all-round training and development of teachers in order to them fit for conducting the training based on the model. Teachers shall be upgraded in basic and engineering disciplines such as machinery and electricity, in general education such humanities, economics and management, and professional skills such as entrepreneurship, cooperation, team work and communication. In carrying out their duties, teachers are expected to demonstrate the training results of engineering projects on time, forward and share new knowledge and technology, widen students' knowledge, inspire students for search new knowledge and skill to develop, and expand students' innovative capability.

EPIP model used local and international skill competition as an assessment tool to evaluate the effective implementation of the EPIP-based curriculum. It is presumed that the competition encourages learning and teaching. It promotes the competition among students beyond class room at local and international level ensuring that the teaching model produces students to the international standard or level. It's known that the traditional evaluation of students is confined to the classroom level.

## **5. Assessment result of the training**

The training was assessed using a survey questionnaire method with two questionnaires prepared for the trainees and trainers.

The trainers and the training coordinators strongly agreed that a training strategic document was prepared with defining clearly the training objectives, and then the training was evaluated at the end confirming that the objective was met. According to them the training equipment were advanced and were the latest technology in the industry, the training was flexible and accompanied with field visit and participation in skill contest. The training was project-based

that encouraged trainees' participation, interaction, group/team work, innovativeness and creativity. The trainer commented that the EPIP model industry standard oriented training is most preferable that allow all trainees actively participate in the training process and cooperate well with each other that the training focus on practical operation exercises. The trainers indicated that the EPIP model training better achieved, if at the end of the training, some real industrial case problem solution and/or scenario for better understanding and/or implementation was included in the training session. The training standard, knowledge, methods, and outcomes are better to be tested and benchmarked via skills competitions with local and international competitors and then providing feedback to improv the provision of the training.

The trainees agreed that the training equipment were advanced and latest technology in the industry with the workshop arrangement was comfortable and equipment were adequate. The training allowed and encouraged participation, interaction and group/team work, and was flexible, innovative, project-based training accompanied with field practice and participation in the international skill contest. They indicated that they learnt new skills and that the training impacted their future carrier in the profession with changing their practice habit profoundly and induced craftsmanship. In their comments trainees assured that they were very interested in the training and highly initiated to integrate it with their specific major field of study to innovate or improve technologies. As EPIP model dictate they recommend that training in the Luban workshop accompanied by industry visit and practice. More Luban Workshop and training in it is essential for cultivating more young talents for the industry.

## **6. Conclusions**

EPIP teaching model is a new training scheme developed by Chinese educators from their huge experience and based on ancient and modern Chinese philosophy. The training of mechatronics using EPIP teaching model in Luban Workshop setup has met its objectives according to the training assessment from the trainees and trainers. The trainers and trainees indicated and highly regarded that the training was project-based that encouraged trainees' participation, interaction, group/team work, innovativeness and creativity that enable them to be competent in the international skill contest. At the end of the training the trained students participated at international level in talent contest and achieved and demonstrated the skill required at the competition.

However, there are lack of materials such as published materials that discussed sufficiently the new teaching model. The implementation and practice of EPIP teaching model and Luban Workshop has not been sufficiently studied. Many studies should be conducted and published works should come forward from those that practice the new model and its training platform (Luban Workshop) that used to carry out the training based on EPIP.



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