ISSN : 2394-2975 (Online)
ISSN : 2394-6814 (Print)
Vol. 6, Issue 3 (July - Sept. 2019)
International Journal of Advanced Research in Education & Technology (IJARET)

Explore Professional Ability for Vehicle Engineering Teachers of Vocational Education -Using Questionnaire

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Abstract

This paper aims to present the explored important professional abilities for engineering teachers of vocational education. The professional abilities were collected from job observation, literature reviews of engineering body of knowledge, and teaching profession. They were organized in to two constructs, mainly focused on the engineering and science capabilities required for vocational engineering teachers to accomplish their job proficiently. The quantitative method, multi-item likert- scale type questionnaire and non-probability quota sampling technique was utilized to collect data. The 22 item Professional Capability Identification Questionnaire (PROCAPIQ) had been administered online for participants invited from teachers, students and industry experts. The analysis result of perceptions of respondents on important engineering and science capability shows; the respondents were highly emphasized the science capability as most important capability for VET engineering teachers. This finding reveals the vocational teachers and management bodies should give credit for the science capability to support teaching engineering at vocational institution.

Key words

Professional Ability, Engineering Teacher, Engineering Capability, Science Capability, Vocational Education

I. Introduction

Technical and Vocational Education and Training (TVET) system plays a vital role in the social and economic development of a nation. The nation's sustainable development will be achieved when the vocational education system produces quality workforce that can manage the job at industries. At the 21st century knowledge driven economy, the rapid growth and spread of science and technology forced industries to upgrade or change their production machineries, systems, service and human capacity in order to compete in the global market by providing quality products or services with attractive price. The highly skilled workforce demand by industries might get answer from vocational education providers. Historically, even at the emergence of industrialized economy there was a mismatch between the vocational school graduates and industry demand. Even though there are many factors that contribute to the occurrence of the gap, teachers capability is believed to be the most influential factor for quality training. According to the literature argument, demand is increasing throughout the U.S. economy and around the world for "knowledge technologists" with a wide range of education, training and skills. Worldwide employers are struggling to fill available positions not because there aren't enough workers, but because of "a talent mismatch between workers' qualifications and the specific skill sets and combinations of skills employers want" (Manpower, 2010).

According to (OECD, 2005, p.7) survey report, the teacher quality is mentioned as a variable that affects students' achievements as "…In particular, the broad consensus is that "teacher quality" is the single most important school variable influencing student achievement…". Since, teaching quality has great impact on students' career performance, and teachers are the core actor in quality training delivery; a covered and unsolved professional ability problem of teachers drastically affects the vocational education training quality. Thus, teachers professional ability problem (knowledge and skill Gap) should be studied and solved periodically. To assess teacher's knowledge and skill gap what knowledge and skill the teacher is expected to demonstrate must be known.

Background of the study

The competent work force demand created in industries is a challenge for TVET sectors. The demand forced TVET sectors to check the training provision capacity, and to revise or change policy, teaching curriculum, training facilities and staff capacity. The argument of conference report (NEXTGEN EDUCON, 2013, p.20) highlighted the challenges as "With the advent of rapid globalization, emergence of information and communication technology and international and regional competitions, educational systems face significant challenges".

The association between TVET sector and industries might be always strong, for such matter TVET needs to stand alert to respond quickly for any new knowledge and skill demand signal that has been send by industries. As per the argument of (Caillods, 1994, p.29) vocational education and training are indispensable instruments for improving labor mobility, adaptability and productivity, thus contributing to enhancing firms competitiveness and redressing labor market imbalances.

Profession

Every job in the world needs a person that can do it well. Some jobs can be done traditionally without formal training and others demands formal training. The job that seeks training and qualification is said to be Profession. Oxford dictionary define profession as:

A paid occupation, especially one involving training and a formal qualification.

As it is cited in the book review by Tolbert, P. S. (1990), Abbot defines profession loosely as:

Exclusive occupational groups applying somewhat abstract knowledge to particular cases.

As it is cited in (Nathan Glazer, 1994), A. M. Carr-Saunders and P. A. Wilson recognized a profession as: *"a vocation founded upon prolonged and specialized intellectual training which enables a particular service to be rendered. ''*.

Engineering teacher

According to the literature (ABET, 2008), Engineering can be defined as:

the profession in which knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize economically the materials and forces of nature for the benefit of mankind.

Engineering is directed to developing and providing infrastructure, goods and services for industry and the community. Engineering can be described as a broad field that embraces knowledge and training in business/management, science, mathematics, social science and (computer) technology (Niguyuan, 1998).

What is the role of an engineer?

As per the literature of (Niguyuan, 1998) Engineers are involved in the implementation, application, operation, design, development and management of projects and processes. An engineer, irrespective of specialization (Mechanical, Electrical, Civil, Industrial, etc) in addition to technical skill, must be equipped with the soft-engineering (non-technical) skills to confront new challenges in the ever-changing and multidisciplinary field that constitutes engineering in today's global environment.

Who is engineering teacher?

Engineering teacher is a teacher who is in charge for teaching engineering knowledge and skill. The ideal engineering teacher is an engineer who has content knowledge, pedagogy knowledge, pedagogical content knowledge and skill

Professional ability for engineering teachers of vocational education

A good teacher should have to possess three kind of knowledge; content knowledge (CK), pedagogy knowledge (PK) and pedagogical content knowledge (PCK). In addition to content knowledge engineering teacher of vocational education might possess the following professional ability; these are learning skill, thinking skill, Planning, Facilitation, Communication and Management.

As per the argument in the literature (Hugh Guthrie, et al., 2006), the type of skills and knowledge acquired by VET practitioners to become highly skilled professional need to:

- have a sophisticated pedagogical repertoire
- use more learner-centred, work-centred and attribute-focused approaches, rather than traditional transmission pedagogies
- can work with multiple clients, in multiple contexts and across multiple learning sites
- understand that the integration of learning and work is a major feature of the contemporary work environment.

As it is cited in (The engineering Profession, p.66), engineering professor's responsibility is divided in to three categories: "teaching", "research", and "service". (classroom instruction, course and curriculum development, laboratory development, and the supervision of student projects or theses) were categorized under "teaching" ; while (pursuit of new knowledge, which is then disseminated throughout the professional engineering community by papers published in engineering journals, presentations at scholarly meetings, textbooks, and software) were involved in "research category" and the third area "service" is focused on activities such as (community involvement, participation in faculty governance, public service, and consulting). "Service" refers to many functions expected of engineering professors.

Engineering competences

According to the National Society of Professional Engineers (NSPE, 2013), engineering capabilities suitable for engineering professionals were organized in to three categories, namely, "Basic or Foundational", "Technical", and "Professional Practice". These are described below:

Basic or Foundational Capabilities*: [comprised of],* Mathematics, Natural Sciences, Humanities and Social Sciences. ***Technical Capabilities:****[are also called hard skills & it contains],* Manufacturing/ Construction, Design, Engineering Economics, Engineering Science, Engineering Tools, Experiments, Problem Recognition and Solving, Quality Control and Quality Assurance, Risk, Reliability, and Uncertainty, Safety, Societal Impact, Systems Engineering, Operations and Maintenance, Sustainability and Environmental Impact, Technical Breadth, Technical Depth. ***Professional Practice Capabilities:*** *[are also called employability skills or soft skills, it is comprised of],* Business Aspects of Engineering, Communication, Ethical Responsibility, Global Knowledge and Awareness, Leadership, Legal Aspects of Engineering, Lifelong Learning, Professional Attitudes, Project Management, Public Policy and Engineering, Teamwork. The researcher has been used some of the engineering abilities for this study from the list of National Society of Professional Engineers.

Purpose of the study

This research aims to search the important engineering and science capabilities for engineering teachers of vocational education.

II. Methodology

Research Design

This research has been used a quantitative non-probability, non-experimental, quota sampling cross-sectional survey technique. A quantitative method enables to quantify data and generalise results from a sample of the population of interest. (*Prabhat Pandey & Meenu Mishra Pandey ,2015).*

Sample

The sample size of this research is 200; it is taken as a sample size because other scholars also used the same size for similar researches (Niguyuan, 1998). The participants in this study were divided in to three different groups: Vocational teachers, students and industry experts. The quota given for teachers, students and industry experts was 25%, 60% and 15% respectively. The study was took place at Tianjin University of Technology and Education. The sample size distribution summary is shown under Table1.

Table 1. *Sample Size Distribution Summary*

Participants	Quota	Responded	Useable data	%
Teachers	50	48	45	90 %
Students	120	129	114	95%
Industry Experts	30	63	27	90%
Total	200	240	186	93%

Research Tools

The tool used to gather data was the developed 22 item professional capability identification questionnaire (PROCAPIQ) shown in the Appendix. The questionnaire was organized in to two domains. The first domain (engineering domain) contains 12 items while the second domain (science domain) contains 10 items; the 22 items

are described below. The item were primarily collected from job observation, National Society of Professional Engineers (NSPE, 2013, p.28), and (Sonia Guerriero , 2012, p.6).

Engineering domain

Engineering domain has the following capabilities:

- Vehicle troubleshoots & diagnosis: the ability to find a fault of vehicle using diagnostic equipments and flow chart.
- Engine management: the ability to explain and demonstrate engine control type & operation.
- Driveline dynamics: the ability to explain and demonstrate power transmission and its effect.
- Engineering drawing: the capability to draw engineering drawing (Mechanical drawing).
- Machine drawing: the capability to draw machine parts.
- Disassembly of mechanical components: the capability to disassemble mechanical parts of a vehicle. (e.g. engine, brake etc)
- Measurements of mechanical components: the capability to measure mechanical components of a vehicle.
- Assembly of mechanical components: the capability to assemble mechanical components of a vehicle.
- IC engine: the capability to explain and demonstrate the classification, construction, operation and service of an IC engine.
- Electric vehicle: the capability to explain and demonstrate the classification, construction, operation and service of an Electric vehicle.
- Hybrid vehicle: the capability to explain and demonstrate the classification, construction, operation and service of Hybrid vehicle.
- Problem solving: the capability to apply mathematics to solve vehicle engineering problems.

Science domain

Science domain has the following capabilities:

- Learning: the capability to learn new things and face new challenge in career (e.g. upgrading, participate in workshop, participate in seminar, etc).
- Scientific research: the capability to conduct problem solving researches.
- Scientific conference: the capability to lead or participate in scientific conference.
- Leadership: the capability to lead the staff to attain the strategic plan of the department or school.
- Teamwork spirit: the capability to share ideas and experiences with colleagues or others.
- Creative thinking: the capability to thought and bring valuable concepts/ ingenuity.
- Counseling: the capability to consult students and create vocational awareness.
- Pedagogy: the capability to plan, teach and manage class room.
- Psychology: the capability to know the learners and give appropriate response.
- Supervision: the capability to supervise student's project or thesis.

III. result and Findings

This section of the article dealt about the results obtained by analyzing data using SPSS, it discusses on the two research questions and answer them based on the respondents perception score.

Q1. What are the important engineering abilities for VET engineering teachers?

The 12 engineering domain items were ranked based on their mean score and the analysis of perceptions of the three participants are explained below. Teachers' perception analysis result on important abilities for engineering teachers of vocational education reveals that they have more emphasis on the following three engineering abilities: "IC engine", "Disassembly of mechanical parts" & "measurements of mechanical parts". They were ranked 1st, 2nd & 3rd, their relative M is 3.42; 3.13; & 3.13 and SD is 1.27; 1.39; &1.43 respectively. "Assembly of mechanical components", "Vehicle troubleshoots & diagnosis" and "engineering drawing" were perceived as important capability and placed in the rank order from 4th thru 6th with the M of 2.91; 2.88; &2.88 and SD of 1.42;1.44;&1.46 respectively. "Hybrid vehicle", "electric vehicle", and "problem solving" were perceived as important capabilities for engineering teachers of vocational education and placed in the rank order from 7th to 9th; their M is 2.88; 2.84; &2.8 and SD is 1.33; 1.39; & 1.21 respectively. "Machine drawing", "engine management", and "Driveline dynamics" were perceived as important capability for VET engineering teachers and placed in the rank order from 10th to 12th, their M is 2.68;2.64;2.55 and SD is 1.47; 1.43; & 1.30 respectively. Meanwhile, Students' perception depicts that the first three high ranked abilities perceived as most important engineering capability for VET engineering teachers are, "IC engine", "Problem solving", and "Hybrid vehicle", with the M of 3.57; 3.36 &3.35 and SD of 1.17; 1.23; &1.31 respectively. They perceived from 4th thru 6th rank as important engineering capability were "Electric vehicle", "Vehicle troubleshoot" and "Engine management" their M is 3.32; 3.28&3.21 and SD is 1.36; 1.41; &1.32 respectively. Items ranked from 7th thru 9th were, "Disassembly of mechanical parts", "Engineering drawing" and "Measurements of mechanical parts", they was perceived as important capability for VET teachers with the M score of 3.21; 3.18; & 3.14 and SD of 1.34;1.30; &1.26 respectively. The students' perceptions for items ranked from 10th thru 12th were, "Assembly of mechanical parts", "Machine drawing" and "Drive line dynamics", their M score was relatively lower than the others but they are also important capability. Their relative M is 3.13; 3; &2.83 and SD is 1.34; 1.29; &1.3 respectively.

According to industry experts' the first three top ranked abilities such as "Disassembly of Mechanical parts" , "Measurements of mechanical parts", and "Assembly of mechanical parts" were perceived as most important ability for VET engineering teacher; their M is 4.14; 4.11; &4.11 and SD 1.06;1.12;&1.05 respectively. "Hybrid vehicle", "electric vehicle" and "IC engine " were perceived as important capability for VET engineering teachers, rank ordered from 4th to 6th, their M is 4.03; 4; &3.92 and SD is 1.09; 1.20; &1.10 respectively. "Problem solving", "Vehicle troubleshoot & diagnosis" and "Drive line dynamics", were perceived as important abilities for teachers and they was ranked 7th to 9th , and their relative M is 3.92; 3.88; &3.77 and SD is1.07;1.12;&1.12 respectively. In the rank order of 10th to 12th the abilities perceived by industry experts as important were contained, these are: "Engine management", "Machine Drawing" and "Engineering Drawing" with the relative M of 3.70; 3.70; &3.59 and SD of 1.17;0.99;&1.15 respectively.

Q2. What are the important science abilities for VET engineering teachers?

In the science domain teachers were responded the following 3 capabilities ranked from 1st to 3rd as most important such as, "teamwork", "learning" and "leadership" with a M of 4; 3.91; and 3.7 and SD of 1.12; 1.23; &1.17 respectively. Teachers perceived "scientific research", "supervision" and "psychology" ranked from 4th thru 6th as important capability, their relative M score is 3.4; 3.33; &3 and SD is 1.35; 1.18; & 1.22 respectively. "Pedagogy", "counseling", "scientific conference" and "creative thinking" ranked from 7th thru 10th have a M score of 2.97; 2.97; 2.91; &2.64 and SD of 1.40; 1.23; 1.22; & 1.15 respectively and were perceived as important capability for VET engineering teachers. Students' perception on the important science capability for VET engineering teachers were "Teamwork", "Learning" and "Leadership" ranked from 1st to 3rd with a relative M score of 3.92; 3.78; &3.75 and SD of 1.11;1.28;&1.15 respectively. In addition to this, "Scientific research", "Creative thinking" and "pedagogy" ranked from 4th to 6th was perceived by students as important science capability for the teacher; they scored a relative M of 3.35; 3.32; &3.3 and SD of 1.28; 1.15; &1.24 respectively. "Psychology", "Supervision", "Counseling" and "Scientific conference" ranked from 7th thru 10th were also perceived as important science capability. Their relative M is 3.28; 3.22; 3.09; 2.98 and SD is 1.22; 1.19; 1.23&1.26 respectively.

Industry experts responded the following 3 capabilities ranked from 1st thru 3rd as most important for VET teachers, such as, "Teamwork", "Learning" and "Creative thinking", their relative M is 4.4; 4.18; &3.92 and SD is 0.74; 1; &1.03 respectively. "Supervision", "Pedagogy" and "Scientific research" ranked from 4th thru 6th was perceived as important science capability for VET engineering teachers having a M of 3.92; 3.88; &3.85 and SD 1.23; 1.08; &1.19 respectively. Industry experts believed the following four capabilities ranked from 7th to 10th were also important for the teachers, these are: "Counseling", "leadership", "Psychology" and "scientific conference" with a relative M of 3.81; 3.77; 3.66&3.66 and SD of 1.21; 1.28; 1.14; &1.14 respectively.

IV. Summary and Conclusions

To summarize the research findings; teachers were picked up science capability as most important esp. teamwork, learning, and leadership than other engineering capabilities. Similarly, students show higher desire on science capabilities for VET engineering teachers than engineering capabilities e.g. Teamwork, learning, and leadership. Meanwhile, industry experts also gave higher emphasis for science capabilities, (e.g. teamwork and learning) than engineering capabilities.

The responses of the three respondents indicate science ability has great impact on the VET teacher's professional performance. The vocational providers and management bodies should give focus on the teacher's science ability cultivation like teamwork, learning, leadership and scientific research ability. The engineering abilities of teachers especially the technical breadth (practical areas) must be cultivated in collaboration with industry .The identified important engineering and science abilities for engineering teachers of vocational education are help full to build capability framework and teachers performance evaluation framework at vehicle engineering school of vocational institution to maintain effective teaching.

V. Acknowledgment

The researcher would like to acknowledge Professor Zhang Lei and Professor Liang Qin for their unreserved support to complete this article.

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Appendix

Professional Capability Identification Questionnaire (PROCAPIQ)

Part I: Identification of Engineering Capability

Please use a tick mark (√) to show your agreement or disagreement on the following engineering abilities. Use the scale.

1= Not important (NI) 2= Least important (LI)
3= Moderate (M)
4 = Important (I) 5 = Very important (VI)

Q1. How important are the following engineering capabilities for engineering teachers of vocational education?

SN	Engineering Domain Capability	NI	LI	M	I	VI
1	Vehicle Troubleshooting & Diagnosis	1	2	3	4	5
2	Engine management	1	2	3	4	5
3	Driveline Dynamics	1	2	3	4	5
4	Engineering Drawing	1	2	3	4	5
5	Machine Drawing	1	2	3	4	5
6	Disassembly of Mechanical Components	1	2	3	4	5
7	Measurements of Mechanical Components	1	2	3	4	5
8	Assembly of mechanical parts	1	2	3	4	5
9	IC Engine	1	2	3	4	5
10	Electric vehicle	1	2	3	4	5
11	Hybrid Vehicle	1	2	3	4	5
12	Problem Solving	1	2	3	4	5

Part II. Identification of Science capability

Please use a tick mark (√) to show your agreement or disagreement on the following engineering abilities. Use the scale.

1= Not important (NI) 2= Least important (LI)
3= Moderate (M)
4 = Important (I) 5 = Very important (VI)

Q2. How important are the following science capabilities for engineering teachers of vocational education?

SN	Science Domain Capability	NI	LI	M	I	VI
1	Learning	1	2	3	4	5
2	Scientific research	1	2	3	4	5
3	Scientific conference	1	2	3	4	5
4	Leadership	1	2	3	4	5
5	Teamwork Spirit	1	2	3	4	5
6	Creative Thinking	1	2	3	4	5
7	Counseling	1	2	3	4	5
8	Pedagogy	1	2	3	4	5
9	Psychology	1	2	3	4	5
10	Supervision	1	2	3	4	5

Thank you very much for taking your time to complete this questionnaire.