Perceptions of Teachers, Students and Employers on The Required Knowledge, Skill and Work Activities For High Speed Machining Technology Programme Under The Engineering Technology Field

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Abstract

This paper focuses on the required knowledge; skills, and work activities for High speed machining Technology course curriculum and how it is perceived by teachers, students and industry employers. It is part of a major study that examined the construction of a curriculum for High speed machining Technology specialty on the engineering technology field. The overall aim of this study was to contribute to the improvement of the High speed machining Technology curriculum development and engineering technology students' learning by utilizing both theoretical and empirical inquiry. In order to accomplish this, basic questions on the required knowledge, skills, work activities and curriculum development were first investigated. A triangulation approach was used to increase the validity of the empirical part of the study and to enhance the rigorous use of both quantitative and qualitative data. The study results shed light on the need for High Speed Machining Technology programmes. In addition, it proposed a curriculum model for High Speed Machining Technology programmes at the Tianjin University of Technology and Education.

Keywords

Curriculum, Curriculum Development, Higher Education, High Speed Machining Technology, Engineering Technology,

I. Introduction

Unlike the previous time, nowadays cultivating students for specific workplace, citizenship and life in this dynamic world is becoming very crucial question [1]. According to [1] the emergency of "Globalization, new technologies, migration, international competition, changing markets, and transnational environmental and political challenges all drive the acquisition of skills and knowledge needed by students to survive and succeed in the twenty-first century". For the knowledge-driven civilization, meeting the challenges of the 21st century would necessarily changing the aims of education and the expectations people have of what education can provide [2].

Due to the above reasons, the workplace environment mostly the manufacturing industry demands graduates to acquire diverse Knowledge and skills to be fit in this competitive work environment. This situation in general requires people to acquire new knowledge and skills and to work in a more effective way.

Background of the Study

Higher education institutions, in general, are required to educate and cultivate personalities who would be able not only to think individually and creatively but also to successfully act and compete individually or in groups in both national and foreign labour market.

Curriculum in higher education is understood as one of the key concepts by which the idea of higher education is put into practice [3] [4]. At college level, curriculum is regarded as an "academic plan" that implies a deliberate planning process that focuses attention on important educational considerations [5] which will vary by field of study, instructors, students, and institutional goals.

Curriculum informs what the purpose of education should be, what to include in this education, how and when to do it and how to check the effectiveness and think of further improvement in the whole process of education. Any curriculum development process strives for answering the question of how a curriculum is planned, implemented and evaluated, as well as what people, processes and procedures are involved [6] [7]. UNESCO indicates that "most of the broader history of civilization, of economic and social relations, is the history of engineering/technology, engineering applications and innovation" [8].

Engineering/technology education is one of the central elements used to produce human resources for the social and economic development of any society [8] [9]. Engineering/technology education programs provide students with the knowledge, understanding, skills and competences required to be professional technology engineers. These include scientific and mathematical theory, engineering applications, design, problem-solving skills, and communication skills. The National Society of Professional Engineers (NSPE) (2013) [10] refers to the knowledge, skills, and attitudes of engineers as "capabilities", where capability is defined as "what an individual is expected to know and be able to do by the time of entry into professional practice in a responsible role. As pointed out by [11], the requirements of 21st-century engineering are considerable: engineers must be technically competent, globally sophisticated, culturally aware, innovative and entrepreneurial, and nimble, flexible, and mobile.

Engineering Technology Education

With the rapid development of science and technology, the scientific and technological competitions and talents are increasingly becoming the focus of attention. Facing the industrial upgrading of technological development, in order to make the cultivation of engineering science and technology talent adapt to economic and meet the needs of social development, people in various countries working on higher engineering technology education are constantly engaged in practicing and thinking approaches and methods about the reform of higher engineering/technology education [12] cited in [13].

With the intensification of industrial and economic globalization, engineering technology is increasingly moving towards globalization. Under this background, engineering technology education varies because of the different languages, cultures, legal systems, environments and customer preferences in different nations. Society needs engineer to have an international vision, which is able to deal with different business culture and government regulations. The team of engineering practice composed of engineers in different languages, culture, ethnic and geographic distribution. Engineering design will take account of both local and international characteristics [13].

Engineering and technology are critical inputs for economic development and competitiveness hence, a nation's educational program should, among other things, be aimed at solving the problems facing the nation and improving the economy through wealth creation [14] cited in [15].

"Engineering technology education is even more "applied" and less theoretical than engineering science education, though in a broad sense both have a focus on practical application. Engineering technology often overlaps with many of the same general areas (e.g. design/development, testing), but the focus is even more on application than in engineering science (which is, in a somewhat different sense, also about application of science)." from Wikipedia.

Student's Learning in Engineering Technology Education

Spencer and Mehler (2013)[16] pointed out that the goal of science education should be to help students develop four aspects of scientific proficiency, the ability to (i) know, use, and interpret scientific explanations of the natural world; (ii) generate and evaluate scientific evidence and explanations; (iii) understand the nature and development of scientific knowledge; and (iv) participate productively in scientific practices and discourse. According to these authors, such an approach to science and technology teaching will require a shift from the teacher-centered instruction (which was the common practice in science classrooms in the past) to more student-centered methods of instruction. So, the defining feature of these instructional methods, as stated by [16], is who is doing the sense-making. In the teacher-centered instruction the sense-making is accomplished by the teacher and transmitted to students through lecture, textbooks, and confirmatory activities in which each step is specified by the teacher. In these classrooms, the instructional goal is to help students know scientific explanations, which is only part of the first aspect of scientific proficiency. In student-centered instruction, the sense-making rests with the students, and the teacher acts as a facilitator to support the learning as students engage in scientific practices.

Engineering Technology education is a category of education. Broadly speaking, it is a specialized technical education mode for the cultivation of engineering and technology talents, to teach technical science and engineering knowledge and skills as the basic characteristics; in a narrow sense, it refers to school education to train engineering technology talents, whose goal is to create qualified engineers and technologists. Due to the characteristics of engineering activities, engineering education has its own unique attributes, including practicality, comprehensiveness, and innovation [17].

Nowadays, along with the faster development and updating of science and technology, the role of engineering technology is increasing. The cultivation of engineering and technical personnel directly determines the level of engineering technology, the speed of development, and the country's industrial competitiveness. Therefore, all countries around the world, especially industrialized countries, are vigorously promoting the reform and development of engineering education, and striving to cultivate a higher quality of talent to maintain their favourable position in the competition [17].

Curriculum Development in Higher Education

Curriculum is the foundation of the teaching-learning process. It involves developing programs of study (study plans), teaching strategies, resources allocations, specific lesson plans and assessment of students, and faculty development [18]. Given these realities the approach to developing curriculum in higher education institutions is and should be a prime concern for all stakeholders, especially for educators, policy-makers, government, parents and the society at large [18] [19].

Higher education curriculum has historically been considered the work of the faculty. More recently, however, external influences such as society, government, alumni, and others are affecting curriculum development and the curricular change process [20]. In this modern era of the 21st century, Higher education institutions aim to be increasingly demand led, responsive to cultural and economic changes, and capable of providing opportunities for students to acquire both knowledge and skills for employability and lifelong learning. Linked, adaptive processes and interoperable systems are vital to the realization of these aims.

Karseth (2006) [21] views the curriculum in higher education as a social construction where the process of decision-making is seen as socio-political and a cultural process, and asserts that "curriculum as a field of study has not played a central role in the research literature on higher education in Europe".

In connection with college education, [5] define the term curriculum as an "academic plan", which implies deliberate planning process that focuses attention on important considerations, and which will vary by field of study, instructors, students, instructional goals and other things. In other words, curriculum, in the context of higher education, is viewed as "the formal academic experience of students pursuing baccalaureate and subordinate degrees" [22].

Purpose of the Study

The purpose of the study is to explore information about what knowledge, skills and work activities are required for High speed machining Technology program students in the engineering Technology field and to provide empirical evidence on the demand for Engineering Technologist (high speed machining technologist).

II. Methodology

A research design is a plan or strategy that constitutes the conditions and procedures for the collection, measurement and analysis of data, including when, from whom and under what conditions the data will be obtained for the study.

This study has been used a non-experimental design as a method of collecting, processing, and analysing data. According to the aim of the study, it was necessary to use both a quantitative and a qualitative research design. As a start an exploratory study was conducted to gain a better insight and understanding of the research problem.

Quantitative methods require the researcher to use a pre-constructed standardized instrument or pre-determined response categories into which the participants' varying perspectives and experiences

are expected to fit [23].
Quantitative approach involves description in words, exploring to find what is significant in the situation. Qualitative studies are concerned with process, context, interpretation, meaning or understanding through inductive reasoning [23].
Selection of respondents was based on non-probability purposive and convenience sampling. Educators who are teaching in the engineering Technology field and technical subjects, graduating students who are studying in the engineering Technology field at TUTE and manufacturing industry employers in Tianjin were identified. The researcher with the advisory group personally delivered the questionnaires, and through the correct channels asked the relevant participants to complete the questionnaires. In a few cases, the researcher collected the questionnaires the following days; some were collected on the same day. The researcher had 87% response.
25 lecturers and 50 graduating students from Tianjin University of Technology and education and 25 manufacturing industry employers and workers from various organizations in Tianjin completed 100 questionnaires. In the final analysis the sample size was as shown below.

Table 1: The Non –probability Sample size

Participants	Institution/Organization		Total	Responded (useable data)
	TUTE	Industry		
Teachers	25	-	25	22(88%)
Students	50	-	50	45(90%)
Industry employers	-	25	25	20(80%)
Informants	-	-	-	
Total	75	25	100	87(87%)

The questionnaire, incorporating the required knowledge, skills and work activity content, was adapted from job observation, www.onetonline.org and Tianjin University of technology and Education catalogue.
The Knowledge category includes, Engineering and Technology, Mechanical, Mathematics, Design, Production and Processing, Physics, Computers and Electronics, English Language, Administration and Management, Education and Training, Chemistry, Customer and Personal Service, Public Safety and Security, Economics and Accounting, Personnel and Human Resources, Telecommunications, Law and Government, Philosophy and Theology, Foreign Language, Sales and Marketing, and Psychology. The Skill category includes, Mathematics, Critical Thinking, Complex Problem Solving, Active Listening, Quality Control Analysis, Judgment and Decision Making, Systems Analysis, Operation Monitoring, Reading Comprehension, Active Learning, Monitoring, Equipment Selection, Systems Evaluation, Time Management, Coordination, Writing, Operation and Control, Troubleshooting, Technology Design, Negotiation, Instructing, Operations Analysis, Equipment Maintenance, Management of Personnel Resources, Management of Material Resources, Service Orientation, Science, Repairing, Programming, and Installation. The required work activity category includes, Develop manufacturing infrastructure to integrate or deploy new manufacturing processes, Develop or maintain programs associated with automated production equipment, Identify and implement new manufacturing technologies, processes, or equipment, Identify opportunities for improvements in quality, cost, or efficiency of automation equipment, Install and evaluate manufacturing equipment, materials, or components, Monitor or measure manufacturing processes to identify ways to reduce losses, decrease time requirements, or improve quality, Oversee equipment start-up, characterization, qualification, or release, Prepare layouts, drawings, or sketches of machinery or equipment, such as shop tooling, scale layouts, or new equipment design, using drafting equipment or computer-aided design (CAD) software, Recommend corrective or preventive actions to assure or improve product quality or reliability, Coordinate equipment purchases, installations, or transfers, Create computer applications for manufacturing processes or operations, using computer-aided design (CAD) or computer-assisted manufacturing (CAM) tools, Estimate manufacturing costs, Select material quantities or processing methods needed to achieve efficient production, Design plant layouts or production facilities, Ensure adherence to safety rules and practices, Verify weights, measurements, counts, or calculations and record results on batch records, Develop production, inventory, or quality assurance programs, Operate complex processing equipment, Operate sophisticated High speed machines (turning and milling), Train manufacturing technicians on topics such as safety, health, fire prevention, or quality, Plan, estimate, or schedule production work, Erect manufacturing engineering equipment, Perform routine equipment maintenance, Repairing and Maintaining Mechanical Equipment, Using computers and computer systems (including hardware and software) to program, write software, set up functions, enter data, or process information.
This questionnaire, of which there were three versions, one for Teachers, one for Students and the other for employers, was employed to determine their perceptions towards the required knowledge, skills and work activity for high speed machining Technology graduates as indicated by their priorities of these categories. The priorities were determined by getting the respondents to rank the list using a scale ranging from 1 denoting not important (not required) to 5 denoting extremely important (extremely required) for each of the list under the category.

III. Research Findings

For Data analysis, the statistical software, SPSS, and Microsoft excel has been used, this section discusses on the three research questions and answer them based on the respondents perception score.

Students, Teachers and Employers Perceptions of High Speed Machining Technology required knowledge.

Table 2 shows the mean values and ranking of each required knowledge as perceived by students, teachers and employers.

Table 2: Students (n=50), Teachers (n=25) and Employers (n = 25) Perceptions of required knowledge (top 10) for High speed machining technology programme.

Required knowledge (Top 10)	Mean	SD	Rank
Mechanical	4.5	.7716	1
Design	4.42	.781	2
Engineering and Technology	4.38	.774	3
Production and Processing	4.25	.809	4
Mathematics	4.15	1.001	5
Computers and Electronics	3.98	.947	6

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English Language	3.92	1.023	7
Foreign Language	3.90	.955	8
Physics	3.75	1.080	9
Public Safety and Security	3.65	1.099	10

Scale: 1 = not important to 5 = extremely important

Table 2 reveals that the highest ranked required knowledge as sought by participants as a single entity are Mechanical knowledge (mean = 4.5, SD = .716) and design knowledge (mean = 4.42, SD = .781) and followed by Engineering and Technology knowledge (mean = 4.38, SD =.774) while the lowest ranked are Personnel and Human Resources knowledge, and Philosophy and Theology knowledge with a mean of 3.25 (SD = .1.080) and 3.00 (SD= .1.240) respectively.

Students, Teachers and Employers Perceptions of High Speed Machining Technology required skill.

Table 3 focuses on the mean values and rankings of each required skill as perceived by students, teachers and employers. Interestingly, for participants, Troubleshooting skill (mean 4.45, SD= .783) was ranked as extremely important, followed by Technology Design skill mean 4.42, SD= .747) and Systems Analysis skill (mean 4.30, SD= .791). In the rank order the least required skills perceived by the participants are Negotiation skill and Persuasion skill with a mean of 3.42 (SD = .747) and 3.35 (SD= .975) respectively.

Table 3: Students, Teachers and Employers Perceptions of High speed machining technology required skill.

Required skill (Top 10)	Mean	SD	Rank
Troubleshooting	4.45	.783	1
Technology Design	4.42	.747	2
Systems Analysis	4.30	.791	3
Time Management	4.30	.833	4
Active Learning	4.30	.883	5
Complex Problem Solving	4.20	.823	6
Operation Monitoring	4.20	.883	7
Equipment Maintenance	4.20	.758	8
Science	4.20	.823	9
Operation and Control	4.18	.984	10

Scale: 1 = not important to 5 = extremely important

Students, Teachers and Employers Perceptions of High Speed Machining Technology required work activities.

Table 4: Students, Teachers and Employers Perceptions of High speed machining technology required work activities.

Required work activity (Top 10)	Mean	SD	Rank
Select material quantities or processing methods needed to achieve efficient production	4.60	.632	1
Operate sophisticated High speed machines (turning and milling)	4.42	.747	2
Prepare layouts, drawings, or sketches of machinery or equipment, such as shop tooling, scale layouts, or new equipment design, using drafting equipment or computer-aided design (CAD) software	4.40	.955	3
Repairing and Maintaining Mechanical Equipment	4.40	.744	4
Identify and implement new manufacturing technologies, processes, or equipment	4.38	.667	5
Develop manufacturing infrastructure to integrate or deploy new manufacturing processes	4.32	.859	6
Using computers and computer systems (including hardware and software) to program, write software, set up functions, enter data, or process information	4.31	.863	7
Operate complex processing equipment- 4.30, .992	4.30	.992	8
Create computer applications for manufacturing processes or operations, using computer-aided design (CAD) or computer-assisted manufacturing (CAM) tools	4.30	.791	9
Monitor or measure manufacturing processes to identify ways to reduce losses, decrease time requirements, or improve quality	4.28	.784	10

Scale: 1 = not important to 5 = extremely important

Table 4 indicates Students, Teachers and Employers Perceptions of High speed machining technology required work activities. Participants' perception analysis result on required work activity for high speed machining technology programme reveals that they have more emphasis on the following three work activities: Select material quantities or processing methods needed to achieve efficient production, Operate sophisticated High speed machines (turning and milling), and Prepare layouts, drawings, or sketches of machinery or equipment, their relative mean is 4.60; 4.42; & 4.40 and SD is .632; .747; & .955 respectively. The lowest ranked are Plan, estimate, or schedule production work, and Coordinate equipment purchases, installations, or transfers with a mean of 3.90 (SD = .871) and 3.85 (SD= 1.122) respectively.

IV. Summary and Conclusions

This study has discussed the students, teachers and employers' perceptions towards the required knowledge, skill and work activities for high speed machining technology graduates. The findings show that not all required Content Knowledge, skill and work activity were perceived by respondents as being equally important. For example, respondents identified Mechanical, Design, Engineering and Technology, Production and Processing, and Mathematics as an extremely important knowledge for success in the engineering technology field. Troubleshooting, Technology Design, Systems Analysis, Active Learning, Time Management and Complex Problem Solving as extremely important skills that students need for success in the engineering technology field. Also Select material quantities or processing methods needed to achieve efficient production, Operate sophisticated High speed machines (turning and milling), Prepare layouts, drawings, or sketches of machinery or equipment, Repairing and Maintaining Mechanical Equipment, and Identify and implement new manufacturing technologies, processes, or equipment as an extremely important work activities. The identified required knowledge, skill and work activities for high speed machining technology program are help full to construct the high speed machining technology proramme curriculum to maintain the cultivation of talented students for the engineering technology field.

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