Mathematics Requirements for Vocational and Technical Education in Iran

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Abstract

Mathematics is considered as one of the most important basic skills for everyone in every community. However, most employees and those entering the work market fail to successfully deploy mathematical knowledge in their work. There are major difficulties faced by the students in learning mathematics in technical and vocational education both in secondary and post-secondary schools in Iran. Therefore, the authors have decided to look at the mathematics programs curriculum to answer this question: what mathematics content is required in the vocational and technical education? This paper describes an instrument to determine the kind of mathematics required. Several questionnaires were created based on Iranian mathematics curriculum standard for Civil, Geotechnical, Ceramic industrial, Wood industrial, Chemical industrial, Electrical, Metallurgy industrial and Mechanics Courses. The result from these questionnaires will help the curriculum planners to develop appropriate mathematics curriculum in secondary school level, post-secondary school level and the university level.

Keywords:Vocational and technical education, *Vocational Mahtematics, mathematics curriculum*;

1. Introduction

Mathematics is one of the most important basic skills for everyone in each community. However, most employees and those entering the work market fail to successfully deploy mathematical knowledge in their work (Pucel, 1992) .The evidences show that the vocational Mathematics Curriculum is not a serious concern for mathematics education researcher (FitzSimons, 1997, 2005; Strasser, 1994; Strässer, 2007). However, some researchers have tried to study invisible topics in vocational and technical educations (Bakker, Hoyles, Kent, & Noss, 2006). Mathematics in vocational and technical education is referred to as just numeracy and considered as literacy (Buckingham, 1998). In developing vocational mathematics curriculum, many goals need to be considered including changing of workplace and the new work order, the nature of the mathematical skills required in modern workplaces, the combination of curriculum, teaching, and environments that facilitate the transfer (Bakker, et al., 2006; FitzSimons & Godden, 2002; Kent, Bakker, Hoyles, & Noss, 2011). Mathematics skills, according to technical and vocational education, are suggested for the presentation of the mathematics content. It means presenting the mathematics content that are needed in a work place.

Developing curriculum in vocational and technical education is based on job analysis in Iran. This approach often uses consensus technique of professionals' judgment. Understanding and managing the workforce and work market are required for job analysis. The job description is based on the job analysis. In recent years, dedicated activities are put forward to identify mathematics learning issues. However, only few studies have been done to determine mathematics requirement for technical and vocational educations. To identify what kinds of mathematics content is needed for those who are studying in technical and vocational education, several questionnaire are created for Civil, Geotechnical, Ceramic industrial, Wood industrial, Chemical industrial, Electrical, Metallurgy industrial and Mechanics Courses. The questionnaires can determine the mathematics content required for technical and vocational education. Considering reviews, two general approaches are used to determine the mathematics required for technical and vocational education: occupational analysis or job analysis and standard testing. The later is about assessing the level of student's mathematics skill. Consequently, it yields a result or grade that shows students deficiencies. As can be seen, this approach is used to reveal their ability to do a specific job without concerning on

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providing educational opportunities to meet the mathematics requirements. In addition, the mathematics requirements are identified by a standardized test for a current job or preparing individuals for future job. That standardized testing approach is rarely chosen in identifying the mathematics requirement because it is difficult to obtain a sample representative of people who are successful on the job. It also contains test norms and rubrics that provide sufficient information. Therefore, job analysis is chosen to determine the mathematics requirement for technical and vocational education (Pucel, 1992).

2. Job analysis

Job analysis is used by technical and vocational trainers to determine the main skills required for a specific job as a main framework for the development of a training program. Therefore, the main objective for providing job analysis is to determine the requirements of a specific job that enable people to meet the job requirement. In addition, expert judgment and group agreement techniques are frequently used in job analysis to present a list of mathematics skills needed for a specific job.

Job analysis is a job description in the form of a formal statement of responsibilities and qualities that are necessary for the success of a specific job. The purpose of writing job analysis is to provide a deep understanding of the competencies required in order to be successful. Competencies and qualifications are the important factors in technical and vocational education. A job competency is a behavior that is essential to implement a specific work task or to gain a specific goal (Prien, Goodstein, Goodstein, & Gamble, 2009). In other words, human resource management needs an understanding of the task that people can accomplish in the organization. The process to understand these competencies or qualification is a job analysis; therefore, the documentation of the result of analysis leads to a job analysis. The major difficulties in conducting a job analysis, in terms of mathematics skills, are in determining the ways of identifying mathematics skills including assembled group opinion and formal analysis, and the math skill taxonomy as a basis for analyzing mathematics requirements. Iranian technical and educational curriculum is based on job analysis. However, the mathematics content is not according to job analysis. The literature has shown a team who identified mathematics skills need to be consisted of mathematics expert and occupational expert.

There are three kinds of job analysis to determine mathematics requirement: analysis of a specific job to find the mathematics skill requirement, analysis of occupational mathematics skills based on the requirement in an educational program, and identifying general skills required for the occupations as a whole.

3. Iranian mathematics curriculum in high school and post secondary school

Based on NCTM (2000) “the content standard includes number and operations, algebra, geometry, measurement and data analysis”(p 29). The distribution of the mathematics from pre-school until K-12 is shown in figure1.

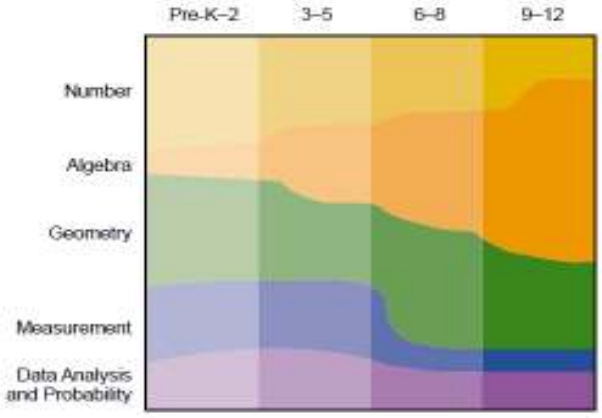

Figure 1. Different mathematics content cited from NCTM 2000

Mathematics curriculum in Iran is classified into 5 parts including: number concept, measurement, geometry, data analysis and probability, and algebra and function (Haji Babaei, Rastegar, Raeisi, Rastegar, & Gholam azad, 2003).

Consequently, mathematics textbook is developed based on these classifications. Mathematics for those are studying in technical and vocational education is similar to those who are studying in an ordinary high school that want to continue their education in the tertiary level. The high school mathematics content within the duration of three years is presented in table 1.

Table 1. Mathematics content presented in Iranian curriculum in secondary school

course	Mathematics I	Mathematics II	Mathematics III
content	Numbers and exponential	Sequences	Number axis
	Sets	Function	Intervals
	Power and root polynomials	Specific function Inequalities	Domain of function Combination of functions
	Linear equations	Logarithmic and exponential function	Limit and continuity
	Trigonometry	Trigonometry	Derivative
	Rational expressions	Matrices	Derivative and its application
	Quadratic equation and solutions	Permutation	Approximation

The mathematics curriculum in post secondary schools is the same as the high school but it is of a more advanced level and it includes much more concepts in calculus. The curriculum emphasizes on limitation, integral and application of integral.

4. Occupational Mathematics Requirements Assessment (OMRA)

The occupational mathematics requirements assessment(OMRA) was designed to identify the mathematics requirement needed for a specific job (Pucel, 1992). The result of OMRA can be applied to develop a framework for mathematics curriculum in technical and vocational education. In other words, the final result for assessing mathematics required for occupations is called the OMRA which includes two parts: first, the OMRA Coordinator Manual that includes instructions for those who are responsible for assessing; the second part, OMRA instrument consists of the OMRA inventory which is applied by expert in both mathematics and occupational areas to determine the mathematics requirements for a specific job. It is used to record sample job applications according to each operation appropriately. Mathematics operation required for a specific occupation can be determined by OMRA; developing a mathematics framework and job application is based on OMRA. The taxonomy of mathematics skills used in OMRA is based on occupation mathematics principles. The questionnaire consists of the usage of technology (e.g. use of calculator). This list is a design based on school mathematics in discrete manner rather than hierarchy of mathematics concepts. This list is rarely understood by a non-mathematics expert and the mathematics concepts are presented verbally. Therefore, the list was revised to enhance consistency and the inability to find and record math concepts quickly by both occupational and math experts. The version is presented in matrix form. This format is design to classify the types of mathematics requirement and then to look down the column to identify the level of complexity of mathematics chosen by user.

5. Methodology

These questionnaires were designed to answer the question: what kinds of mathematics content are needed for the technical and vocational education in secondary and post secondary school? The questionnaire was divided into two main parts: horizontally and vertically. These two main parts are shown in figure 2. It combined the OMRA inventory with the Iranian mathematics curriculum. However, some things were added to achieve the objectives; for example, some columns were added based on expert viewpoints. In addition, mathematics concepts were considered hierarchically in contrast to OMRA inventory. The horizontal part consisted of mathematics content. To create this part, “math and your career competency List” was applied, which was used in the OMRA inventory. Some changes were made in this list based on the Iranian Mathematics curriculum and the mathematics content that was presented in technical and vocational education. For example, calculus was put in a column separately. Two additional columns namely “using tools” and “interpretation of graphs” were added. These two columns were added based on

experts' point of views in the engineering areas. As can be seen, the questionnaire includes nine columns from left to right. The first column is the name of the textbook based on Iranian technical and vocational education. The second column includes the main topics and subtopic of the textbook. It is then followed by another column that consists of general mathematics. The third column comprises of geometry and the forth includes algebra I, the fifth is on algebra II, the sixth includes calculus, the seventh includes the usage of tools and the last column includes interpretation of the graphs.

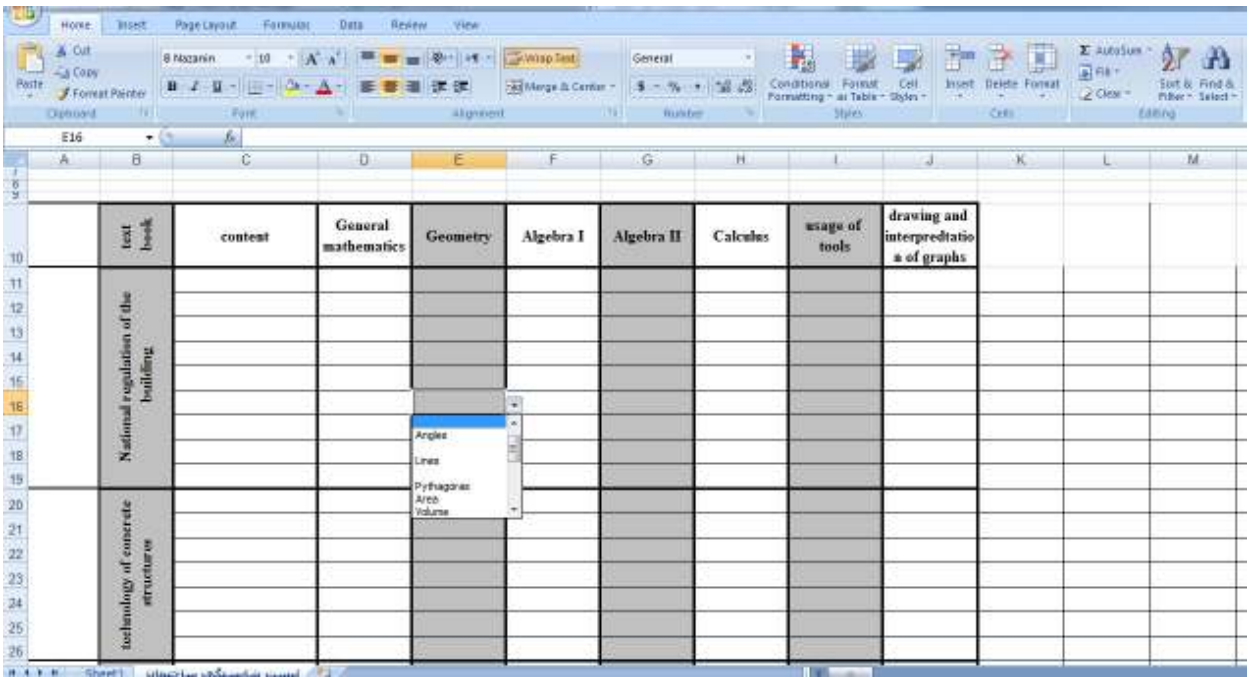

Figure 2.part of the questionnaire

The mathematics content of each column is presented in table 2. As can be seen, higher level of mathematics content like calculus is put in a column separately. Other columns of the questionnaire cover both the mathematics content and the Iranian mathematics syllabus. The mathematics content is placed in a hierarchically manner. The lower row includes the upper row. The questionnaire is designed in Excel format. Therefore, it is a dynamic questionnaire.

Table 2. mathematics curriculum content

General	Geometry	Algebra I	Algebra II	calculus	Use of tools	Interpretation of graphs
Whole number	Induction, deduction, and logic	Linear equations	trigonometry	Limit and continuity	Use a calculator	Drawing the bar chart and line chart
Fractions	Parallel lined/planes	Linear inequalities	Linear/quadratic functions	Derivative	Computer programming	Drawing the graph using software
Decimals	Congruent Triangles	formulas	Trigonometric functions	Derivative applications		
Estimation	Similar polygons	Polynomials	Trigonometric identities	Differential		
Quick computation	Circles	Factoring polynomial	Complex number	approximation		
Rounding	Constructions	Rational expressions	2^{nd} degree equations in 2 variables			
Ratio	Distance in plane	Co ordinate graphing	Exponents/logarithms			
Statistics	transformations	System of	Polynomial equations			

	equations		
Metric measurement	Simplifying radicals	Sequences/series	
Area/perimeter volume		Quadratic equations	Permutations/combinations
Geometric concepts			Vectors /determinants
Pythagorean theorem			
Exponent/square root/exponents			
Probability			

6. Conclusion

The research question is about determining mathematics requirements for those who are studying in technical and vocational education in secondary school and post-secondary school. To answer this question, several questionnaires were designed in which a typical one was described in this article. It was developed based on the OMRA inventory, the Iranian mathematics curriculum, and the Iranian technical and vocational curriculum. The questionnaires could dynamically determine every mathematics syllabus in Civil, Geotechnical, Ceramic industrial, Wood industrial, Chemical industrial, Electrical, Metallurgy industrial and Mechanics Courses. Excel applications was utilized to create them. The data collected by using these questionnaires can be applied in training programs. It can also be used in developing mathematics curriculum in technical and vocational education in secondary school and post secondary school. Consequently, it can be applied in engineering courses in the universities. The results of these questionnaires can be used for content analysis in current mathematics text book in school, post-secondary school, and also in universities.

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