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A Study on the Assessment of Key Competencies for Automotive Engineering Technology Education in Korea*

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In order to find out the gaps in key competencies, those of employees in industry and students in college should be analyzed. Key competencies of students and technicians in automotive fields are scaled and compared to each other. Furthermore, the differences between two groups are analyzed to check on the gaps. Initial test sheets are reconstructed as an improved one after the prior assessment reflecting the opinion of industry to execute reliable level assessment. The area and level of key competencies are set up by literature analysis and consultation. The average scale of key competencies is assessed by students and technicians respectively. Numeracy, understanding organization, technology skill, problem-solving, interpersonal relation, communication skill, self-management and development, resource management and information application are selected as key competencies in Korea. Three levels of key competencies are set up. Key competencies of automotive college and industry are compared. Regardless of areas, the gaps between the two are significant shows a kind of discrepancy between industry and college requiring a scheme to fill the gaps.

Keywords: key competencies; gap; automotive fields; assessment; engineering technology education

1. Introduction

Incorporating key competency instruction is a challenge for engineering faculty. Even without taking formal courses, students can make measurable strides in key competencies [1]. Current concerns over reforming engineering education have focused on helping students develop skills and an adaptive expertise. Theoretical underpinnings for some best-practice instructional methods designed to help students develop the specific skill of using mathematics in modeling physical situations are considered [2]. In fact, Özdemir and Andrew [3], in their electronic mechatronics engineering course, assigned students to carry out a project of design, manufacture, test and trial performance of a mobile robot by forming a team. The students were actively engaged in a team work employing engineering technology and system design method for their target. By combining academic and commercial learnings into a modified teaching approach, the success of study skills teaching could be improved [4].

If key competencies are defined as a skill to apply knowledge, understanding, practice and ideas for an effective performance generally required for the job, it regards key competencies as a core of occupational skill. Thus, if anyone lacks suitable key competencies, it means the occupational standard which is required by the national qualification system cannot be fulfilled. By the evidence, two facts are suggested. One is that occupations which require higher skill levels are growing faster than those which require lower skill levels, and the other is that the skills needed in jobs, across the occupational spectrum, are also increasing [5].

The generic skills which individuals need in order to be effective members of a flexible, adaptable and competitive workforce and for lifelong learning cover communication, application of number, information technology, working with others, improving own learning and performance and problem solving. For focusing on key competencies, two motives are identified. First motive is quality in education, stemming from variation in educational attainment from school to school. Second is internationalization, rapid scientific and technological progress, and increasingly complex career paths. More work would be required to overview key competence in general education and vocational frameworks and to track the reasons for this differentiation and the possible cultural/conceptual issues involved. Examination of the educational goals expressed in the curriculum of general compulsory education shows that all of skills and competencies included either implicit or explicit reference to the development of competencies [6]. By the Accreditation Board for Engineering and Technology (ABET), a set of competence-based professional standards; Engineering Criteria 2000 was developed and adopted. ABET reaffirmed professional skills which include communication, teamwork, and understanding ethics and process skills and engineering within a global and societal context, lifelong

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learning, and awareness skills. The ABET professional skills can be taught and assessed [7]. To rate the importance of the ABET competencies in their professional experience, engineering graduates value a top cluster of competencies (teamwork, communication, data analysis, and problem-solving) significantly higher than a bottom cluster (contemporary issues, experiments, and understanding the impact of one's work) with the intermediate cluster (''math, science, and engineering skills,'' ethics, life-long learning, design, and engineering tools) [8].

There is another classification to regard key competencies as a skill to carry out the job successfully regardless of radical social change, occupational types and ranks. Though there are slight differences by nations, key competencies used to contain technology skill, inter-personal relation, problem-solving, numeracy, communication skill, self-management and development, resource management and information application understanding organization, in Korea [9-11]. In this classification, technology skill consists of understanding technology, selecting technology, and applying technology. Inter-personal relation is a skill of cooperation, leadership, conflict management skill, negotiation skill and customer service skill. Problem-solving means thinking skill, problem awareness skill, selecting, application and evaluation of an alternative skill. Numeracy is the skill to understand the four fundamental arithmetic operations, statistics, probability, diagram interpretation and expression. Communication contains reading, writing, listening, speaking, non-verbal expression and foreign language reading. Self-management and development means self-management skill, career development skill, and sound value system and attitude to the occupation. Resource management is defined as resource confirmation skill, resource organization skill, resource planning skill, and resource allotment skill. Information application means information collection, information analysis, information management, information application and computer using skill. Understanding organization includes international sense, system understanding, management understanding and job performance skill [9].

In addition, the conceptualizations of key competencies in diverse aspects, including skill certification [12–13], skill focused education process [14–15], vocational high school and key competencies [16–19], college and key competencies [20–21], and key competencies of adults [22–23] are provided. Also the correlation among key competencies and teacher efficacy [18, 24], project method on the key competencies [25–26], development of key competency model [27–28], and development of the assessment test to measure key competencies [29] are currently being studied in Korea.

2. Methodology

Commonly, to find required competencies, researcher considers two methods in the job world. One is the method to acquire competencies, the other is the mechanism to verify competencies. Meanwhile, industry requires creative and lenient skill to adapt knowledge-based society and to carry out specialized duties to counter the change of structure and technical development. However, there are huge discrepancies between industry and college terms of their competencies. The cooperation between those two is much important part to solve problems to reflect the requirement of the industry needs to be developed. Although customized education in engineering technology education area has been carried out, it has a limitation to accept the requirements due to environment and lack of an operation system. Therefore, it must be the first to find out the gaps between industry and college followed by the development of education curriculum.

In order to find out the gaps in key competencies, those of employees in industrial field and students in college should be analyzed first. So far, many analyses have been made on the necessity of key competencies, but few works have been made to evaluate and analyze key competencies of personnel in industry and college for a purpose of finding gaps in key competencies of both.

Accordingly, with literature analysis to figure out key competencies of both groups, test sheets should be developed to evaluate key competencies. Then, key competencies of both students and technicians shall be examined by areas. The differences in between are going to be investigated.

Assessment criteria must first be classified by their competencies to evaluate numeracy, understanding organization, technology skill, problem-solving, inter-personal relation, communication skill, self-management and development, resource management and information application. An initial test sheet shall be reconstructed as an improved one after the prior assessment reflecting the opinion of the industry to execute reliable level assessment. Specific scopes to find out the gaps of key competencies in automotive fields are as follows [30].

First, the area and level of key competencies should be set up.

Second, test sheets of key competences for automotive fields should be developed based on area and level.

Third, key competencies of students and technicians in automotive fields should be evaluated.

Fourth, the significance of the evaluation results should be analyzed.

When key competencies of both groups are figured out, it enable to set up a plan to develop key competencies of students reaching to the level of technicians in the industry. If any measure to reduce the gaps in between, the priorities of the key competencies are going to be set up too. If the evaluation of the key competencies is not sufficient, re-education should be given to develop the level. If the level satisfies the requirement of the industry, it may make those to be employed in accordance with their competencies and level by constructing cooperation system [13].

The area and level of key competencies are set up by literature analysis and consultation with 20 specialists in six automotive companies. The assessment test sheets for key competencies by areas, such as technology skill, inter-personal relation, problem-solving, numeracy, communication skill, self-management and development, resource management and information application understanding organization, are drawn up in advance. The prior test sheets consist of total 65 question items, including 8 technology skill, 6 inter-personal relation, 7 problem-solving, 11 numeracy, 12 communication skill, 5 self-management and development, 5 resource management, 8 information application and 3 understanding organization. The question items are drawn up with practical contents that students shall encounter in the actual industrial field [31].

After the prior evaluation from above-mentioned specialists, parts of the question items are removed depending on alpha using a SPSS 17.0 program. The test sheets are reconstructed so that Cronbach's alpha is 0.844. Revised test sheets are developed with total 40 question items, including 3 technology skill (alpha if item deleted, 0.843), 4 inter-personal relation (alpha if item deleted, 0.845), 5 problem-solving (alpha if item deleted, 0.841), 7 numeracy (alpha if item deleted, 0.838), 9 communication skill (alpha if item deleted, 0.839), 2 self-management and development (alpha if item deleted, 0.843), 4 resource management (alpha if item deleted, 0.841), 4 information application (alpha if item deleted, 0.841) and 2 understanding organization (alpha if item deleted, 0.845). Evaluation questions are drawn up based on the Likert 5 level scale to satisfy the requirement of statistical treatment. Parts of the test sheets are shown in Table 1.

The objects of assessment are two groups: one is students group, and the other is technicians group. Both are in automotive fields. The assessment of key competencies of students in college, and technicians in industry shall be analyzed. If there is any significant difference, the results should be checked. Lastly, key competencies of students and employees are going to be examined by areas, and the gaps should be confirmed.

220 test sheets are distributed to automobile industries listed in the Korea Automotive Component Research Institute. Another 220 test sheets are given to students of automotive specialized college in Korea. 273 (industry 76, students 197) among 440 are returned. (Return rate 62.0%: industry 34.5%, students 89.5%) 93 which are suspicious in reliability are discarded, and 180 (industry 47, student 133)

Table 1. Parts of the test sheets

☐ Why is it dangerous to touch electronic devices with a wet hand?

① Because moisture increases voltages. ② Because moisture blocks smooth current.
③ Because moisture damages electric devices. ④ Because moisture reduces electric resistance to generate more current ? Because moisture makes the voltage change severe.

☐ How many people do you have to share opinions on your major or duty around you?

① 1–3 ② 4–6 ③ 7–9 ④ 10–12 ⑤ over 13

☐ A plan for the new comer training programs is assigned to a department where K belongs, and K shall be responsible for it. When the following plans are established, what seems better for an efficient execution?

* Training process plan. 1. Select personnel to be trained. 2. Investigate available resources.
3. Select training method. 4. Prepare evaluation. 5. Evaluate the contents of a specific process.

① Change the order between 2 and 3. ② Change the order between 4 and 5.
③ Change the word of 2. ④ Change the order between 1 and 2 ⑤ Delete 4.

☐ The following indicates the import amount of the aluminium load wheel from a German automotive accessory After Market (Unit: DM 1000). How many times does it increase of the export of the German aluminium load wheel in 2009 against 2008?

Country	2007	2008	2009
EU	476,719	522,631	452,693
Italy	218,927	233,088	221,158
Czech	35,322	72,146	101,441
Poland	39,142	29,184	75,695
Austria	63,597	94,168	73,368
Belgium	99,132	78,398	63,715
Korea	626	1,469	12,163
Gross Import	666,968	811,504	809,182

Table 2. Scope and level of key competencies in Korea

Level Detail	Level 1	Level 2	Level 3
Technology Skill.	Skill to understand the technical job. Skill to understand the technical principle of job.	Skill to apply the technical job. Skill to apply technical tool and device.	Skill to monitor and critically think of technical job execution. Skill to apply technical job practically. Skill to connect technical principle to a new situation.
Interpersonal Relation.	Skill to keep the interpersonal relation to achieve an aim. Skill to carry out job with various people.	Skill to improve information-change and working with others. Skill to lead others in carrying out job.	Skill to construct and keep cooperation relation. Skill to improve job by reviewing and by cooperation. Skill to satisfy the other party in job. Skill to resolve conflicts in jobs.
Problem-Solving.	Skill to have clear problem awareness related to job. Skill to explain after the awareness of problems.	Skill to think creatively, logically and critically. Skill to understand the meaning when any problem is found in executing a job.	Skill to select an alternative by reviewing problem-solving plans. Skill to resolve problems by applying the most suitable plans. Skill to figure out problem-solving level as an alternative by analyzing an alternative application results.
Numeracy.	Skill to carry out job. Skill to know the result of numeracy.	Skill to select concept and skill of numeracy in job. Skill to know and draw up diagram.	Skill to select and apply numeracy to solve tasks. Skill to interpret and express diagram.
Communication Skill.	Skill of taking part in discussion. Skill to write a document relevant to. Skill to acquire necessary information through documents.	Skill to lead a discussion. Skill to summary and present the contents. Skill to understand foreign documents.	Skill to suggest discussion direction. Skill to present contents and persuade others. Skill to read and integrate information. Skill to integrate and reflect foreign documents into a job.
Self-management and Development.	Self-confidence, health care, independence, responsibility, motivation, faithfulness, positive mind and courtesy.	Skill to know own interest, aptitude and personality. Skill to counter any situation by self-development.	Law-abedience spirit, job ethics, safety, voluntary spirit, crafts manship, calling for a job. Skill to carry out job confidently.
Resource Application.	Skill to know the necessary amount like time, capital, resource and facility.	Skill to collect and use necessary time, capital, resource, facility, and HR.	Skill to exert application plan of using time, capital, resource, facility and HR necessary for a job. Skill to allot resources like time, capital, resource, facility and HR into real performance.
Information Application.	Skill to collect information for a job. Skill to check, search and record the given information. Skill to carry out job using a computer.	Skill to know aims of information application clearly. Skill to organize, use and confirm information with various media. Skill to evaluate information's connection, accuracy and completeness.	Skill to evaluate validity of the information results. Skill to manage meaningful job into the organized job with various media. Skill to apply organized and managed information at a suitable time. Skill to apply the latest method in information collection, analysis, organization, management and use.
Understanding Organization.	Skill to execute, set up and keep defined activities. Skill to check process and result by applying defined job standard. Skill to check and use the priority order in a job.	Skill to adjust and manage the process to achieve an aim. Skill to maximize quality of result and process in a job. Skill to set up the priority for an effective job.	Skill to include strategic aim into job performance plan and construction. Skill to maximize quality and efficiency in plan, promotion and result of job performance. Skill to include aim, plan and priority with strategic character in the job plan and construction. Skill to understand organization management in a job.

are analyzed. Average, standard deviation and t-Test are executed with $p<0.05$ significance level.

3. Results

3.1 Area and level of key competencies

The area of the key competencies in Korea is technology skill, inter-personal relation, problem-solving, numeracy, communication skill, self-management and development, resource management, information application, understanding organization. The level of key competencies in Korea is set up in three levels suggested [9, 13–14]. The results are shown in Table 2.

3.2 Assessment of key competencies

The average scale of key competencies is assessed by students and technicians respectively. The assessment results of the students are called key competencies of college, and those technicians are called key competencies of industry. As to key competencies of college, technology skill is the highest (average 4.02) followed by communication skill (average 3.76), numeracy (average 3.70), inter-personal relation (average 3.65), information application and understanding organization (both average 3.53), resource management (average 3.51), problem-solving (average 3.40) and self-management and development (average 2.50). For industrial key competencies, technology skill has climbed to a record average 4.55, followed by numeracy (average 4.53), information application (average 4.28), communication skill (average 4.23), resource management (average 4.18), understanding organization (average 4.17), inter-personal relation (average 4.02), problem-solving (average 3.83) and self-management and development (average 3.01).

Both groups have a highest score in technology skill, and lowest in self-management and development. Much effort has been made on technology skill in automotive fields, but it proves difficult to enhance self-management and development. Numeracy exists in high rank comparatively to both groups. Problem-solving is low to both groups, which indicates problem-solving competency is insufficient in automotive fields.

Although the scores between the two group by areas of key competencies are different, the gap of numeracy is largest with 0.83, followed by information application with 0.75, resource management with 0.67, understanding organization with 0.64 technology skill with 0.53, self-management and development with 0.51, communication skill with 0.47, problem-solving with 0.43 and inter-personal relation with 0.37. The gap of numeracy and information application is huge, but that of problem-solving and inter-personal relation is relatively little.

What is the important is that, regardless of areas, the gaps of key competencies between college and industry in Korea are huge generally. T-Test shows significant difference ($p<0.001$) in all areas of both classification, which demonstrates that college needs to devise a scheme to fill the gaps in every key competency. The average of key competencies by areas is shown in Table 3.

4. Conclusions

In this study, technology skill, inter-personal rela-

Table 3. Key competencies of the college and industry

Key Competencies	Classification	N	Average	Standard Derivation	Mean Difference	t
Technology Skill	College	133	4.02	0.98	0.53	4.390***
	Industry	47	4.55	0.59	0.53	4.390***
Inter-personal Relation	College	133	3.65	0.64	0.37	3.373***
	Industry	47	4.02	0.60	0.37	3.373***
Problem-solving	College	133	3.40	0.67	0.43	4.789***
	Industry	47	3.83	0.48	0.43	4.789***
Numeracy	College	133	3.70	0.78	0.83	8.698***
	Industry	47	4.53	0.47	0.83	8.698***
Communication Skill	College	133	3.76	0.78	0.47	5.305***
	Industry	47	4.23	0.38	0.47	5.305***
Self-management and Development	College	133	2.50	0.83	0.51	3.708***
	Industry	47	3.01	0.77	0.51	3.708***
Resource Management	College	133	3.51	0.81	0.67	6.388***
	Industry	47	4.18	0.53	0.67	6.388***
Information Application	College	133	3.53	0.83	0.75	6.831***
	Industry	47	4.28	0.57	0.75	6.831***
Understanding Organization	College	133	3.53	0.99	0.64	4.846***
	Industry	47	4.17	0.69	0.64	4.846***

* $p< 0.05$; ** $p< 0.01$; *** $p< 0.001$.

tion, problem-solving, numeracy, communication skill, self-management and development, resource management, information application, understanding organization are selected as the key competencies in Korea, and their level by areas is defined. The comparison of key competencies between students and technicians in automotive fields are done.

The various efforts has been made on technology skill in automotive electronics, but it proves difficult to enhance self-management and development. Numeracy competency is important and sufficient respectively but problem solving competency is insufficient in automotive fields. To compare the key competencies by areas, the study clearly show the gap between numeracy and information application is the largest. And regardless of areas, the gaps between the both of them are significant. It shows a kind of discrepancy between industry and college requiring a scheme to fill the gaps. By utilizing those results, industry may require suitable personnel to satisfy the need of the type, size, jobs and occupational department beyond a simple category.

College may clarify if a graduate achieves any required levels in key competencies for innovating on current curriculum, including evaluation system in order to nurture students. For this, key competencies shall be evaluated by areas, and their level shall be determined. Moreover, curriculum should be developed to help that students achieve required competencies. The level of key competencies of the industry shall be evaluated by region, size and jobs, and the feedback of the result shall be given to college.

As such, this study is expected to find out the better method to fill the gaps between industry and college with an aim to set up a new supply system of students with key competencies. According to the study, further studies shall be recommended reflecting the change of industry by size of companies, by region considering equivalent development and by jobs considering the differences of duties.

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