
Essential contents for software development process and software quality education

Sun-Myung Hwang

Computer Engineering Department,
Daejeon University,
96-3 Yongwoon-dong Dong-gu,
Daejeon, South Korea
E-mail: sunhwang@dju.kr

Abstract: There are software engineering absences that cause the software quality and productivity increase problems during software development project. There exists necessity awareness of software engineering growth and professional software engineering manpower education. This paper introduces the software engineering standard curriculum to suggest manpower practical-use guide and to establish continuous growth to strengthen manpower ability and expertise. When performing the projects, we can suggest for software engineering professional acquisition and standard to solve them by using standard curriculum for software engineering, which can strengthen manpower capacity the organisational software engineering. This paper provides educational guideline of for software process and software quality.

Keywords: software engineering; software development process; software engineering standard curriculum; software process curriculum; software development process.

Reference to this paper should be made as follows: Hwang, S-M. (2014) 'Essential contents for software development process and software quality education', *Int. J. Engineering Systems Modelling and Simulation*, Vol. 6, Nos. 1/2, pp.44–53.

Biographical notes: Sun-Myung Hwang received his BS, MS and PhD in Computer Engineering from the Chung Ang University in 1982, 1984 and 1987, and Post Doctor in Bonn University in 1988. He is a Professor at the Daejeon University in 1989 to present. His research interests are software quality assurance, process assessment, testing tool, and V&V technology.

This paper is a revised and expanded version of a paper entitled 'Software quality contents: what and how to learn' presented at ICCA: The 1st International Conference on Convergence and its Application, Korea University, Seoul, Korea, 10–12 July 2013.

1 Introduction

There are many problems in a project such as the delay of payment, cost excess, quality deterioration and so on. To solve these problems, the necessity of software engineering increases (Yorozu et al., 1987; Vidmar, 1992). In the major nations where importance of software engineer have been acknowledged, software engineering guide and various types of software engineering education are provided (Lee, 2012; Jones, 1991; Macia-Prez et al., 2012). However, there is no institute for professional software engineering education, and neither is the engineering guide for possible use in industry field. Therefore, systematic software engineering guide to enhance knowledge and skill of manpower at field becomes necessary (Proakis and Salehi, 1993). Software engineering standard curriculum, able to provide a guide to which software development manpower trying to increase productivity can refer and to provide document that can be referred to while operating and developing programme to reinforce software manpower capacity, is introduced. Among the items on the list of software engineering standard curriculum knowledge, this

paper analyse software process and software quality step by step In this paper, the configuration of software engineering standard curriculum is explained in Section 2 continuing from the introduction, and in Section 3 the detail knowledge-lists relating software engineering process and software quality are explained. Finally, the conclusion is made.

2 Software engineering and curriculum configuration

2.1 Software engineering knowledge list

Software engineering is categorised into nine areas and the important knowledge regarding to each area was arranged. And basic concept, techniques and tools to understand knowledge area are provided.

2.2 Software engineering standard curriculum

Education curriculum regarding nine areas of software engineering is suggested, and common software engineering

curriculum possible to be applied in the whole industry is provided. Each area of software engineering is divided into three steps such as beginner, intermediate, and advance. The system map represents 26 subjects correspond to education training contents in each level.

2.3 Study track for expert of software engineering

Tasks of each duty of five areas of expertise, important knowledge and skill suggestion, software engineering study sequences and subjects to enhance duty-carrying capacity.

3 Knowledge list of software engineering process and software quality

In this section, software process and software quality are going to be explained.

3.1 Software engineering process concept

Software process is a series of procedures to develop software and is divided into atypical process, management process, methodological process and enhancement process. The major properties are understandability, visibility, supportability, accommodate, reliability, solidity, maintainability, speed. Table 1 explains the detail contents of the area of software engineering process.

3.1.1 Outline of educational subjects

As shown in Figure 2, the educational subject system is divided into three steps according to each of the nine areas classified in the software engineering knowledge list. Educational subjects at each level of software engineering process area are shown in Table 2.

Figure 1 Software engineering knowledge list

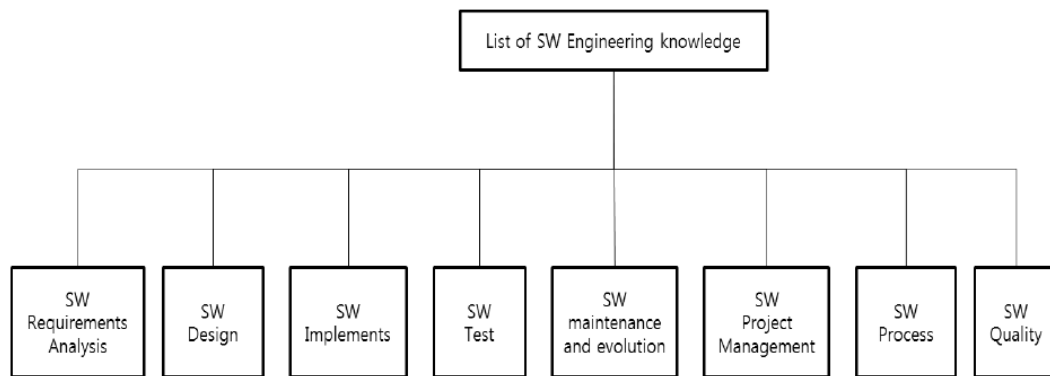


Figure 2 Education system map of each engineering area

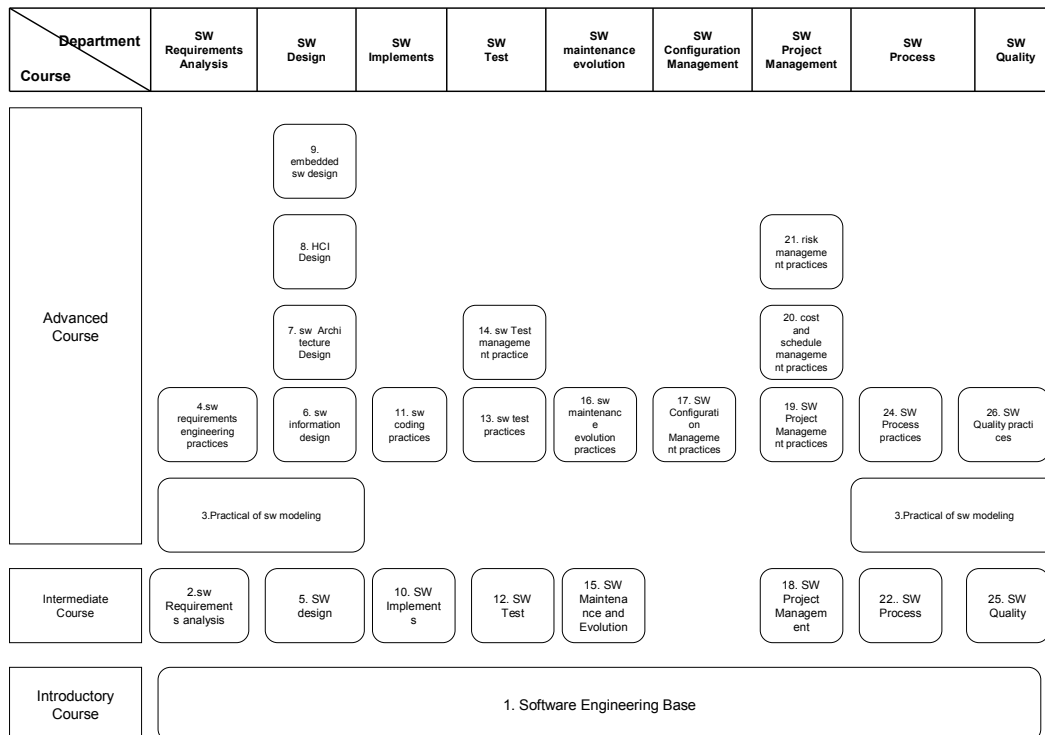
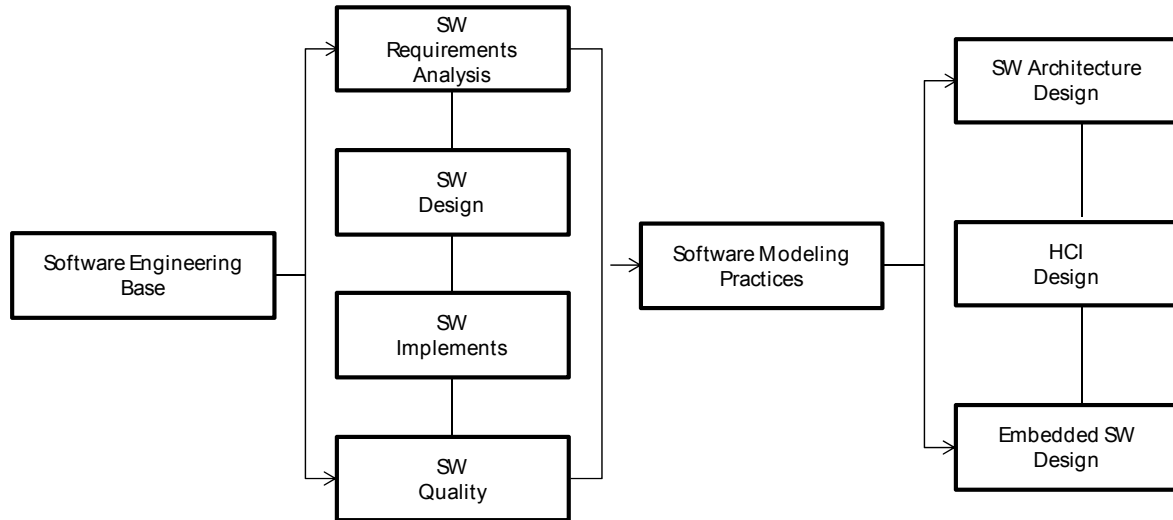


Figure 3 The expertise duty knowledge, skill and study track**Table 1** Detail contents of each area of software engineering process

Knowledge areas	Unit topic	Knowledge items	Item details
SW engineering process	8.1 Concepts of SW engineering process	8.1.1 Type distinction of SW process	Classification of technical-models and meta-models
		8.1.2 Characteristic of SW process	System process, software process
		8.1.3 SW process improvement	Process assessment, certification, improvement
	8.2 SW process improvement and alteration management	8.2.1 Process infrastructures	Expert group, infrastructure, tools
		8.2.2 SW process management cycle	Management-cycle
		8.2.3 Process implements and alteration management model	QIP (quality improvement paradigm) model, IDEAL model
		8.2.4 Process quality assurance hierarchy	SW management and quality assurance Quality assurance organisation
	8.3 Definition of SW process	8.3.1 SW development life-cycle model	Explanation of SW development process Models: waterfall, prototyping, incremental, spiral, v
		8.3.2 System life-cycle process model	System life-cycle process (convention, project based, project, technic process)
		8.3.3 SW life-cycle process	Basic, support, organisation life-cycle process
		8.3.4 Process application	Process definition, process notation
	8.4 Evaluation of SW process	8.4.1 SW process evaluation model	Continuous representation, staged representation CMMI, SPICE, SP certification, ISO9003
		8.4.2 SW process evaluation method	Process assessment, indicators Capability level0~level5 (CMMI, SPICE)
		8.4.3 Process improvement and assessment	Assessment procedure, improvement activity
	8.5 SW process and product measurement	8.5.1 SW product measurement	Internal and external quality element measurement models
		8.5.2 Quality of measurement result	Quality of developer
		8.5.3 Certification of SW quality system	ISO 900003
	8.6 SW engineering process techniques	8.6.1 Process measurement techniques	Process assessment model
	8.7 SW engineering process tools	8.6.2 Process tools	Outline of tool

Table 2 Educational subjects at each level of Software engineering process area

<i>Level software</i>	<i>Introductory course</i>	<i>Intermediate course</i>	<i>Advanced course</i>
Software process	Software engineering foundation	Software process	Software measurement, analyse practical and process practical

Table 3 Software engineering basic education content

<i>Section</i>	<i>Education content</i>	<i>Possessed time</i>	<i>Related document</i>
1 Introduction of software engineering	<ul style="list-style-type: none"> • The concept of SW engineering • The history of SW engineering • The Practical Use of SW Engineering 	3	
2 SW requirement analysis	<ul style="list-style-type: none"> • SW requirement analysis and the concept of analysis engineering • SW requirement analysis process • Requirement elicitation • Requirement analysis • Requirement explicit • Requirement logging • Requirement management 	4	1.1 SW requirement analysis and requirement engineer concept
3 SW design	<ul style="list-style-type: none"> • The concept of SW design basic • SW design process • SW abstract • SW design details • SW documentation • SW logging • SW design and others 	5	2.1 SW design basic concept
4 SW implementation	<ul style="list-style-type: none"> • The concept of SW implementation • SW implementation process • SW configuration • SW coding • SW refactoring • SW implementation logging • SW implementation development language • SW implementation styles and patterns • SW development tools 	5	3.1 SW implementation concept
5 SW test	<ul style="list-style-type: none"> • The concept of SW test • SW test process • SW test schedule and restrain • Error detect process • SW test techniques • SW test validation • SW test verification 	4	4.1 SW test concept
6 SW maintenance and evolution	<ul style="list-style-type: none"> • SW maintenance and evolution concept • SW maintenance and evolution process • SW maintenance and evolution techniques 	3	5.1 SW maintenance and evolution concept
7 SW configuration management	<ul style="list-style-type: none"> • SW configuration management concept • SW configuration management process and schedule 	3	7.1 SW configuration management concept

Table 4 Software process educational content

<i>Section</i>		<i>Education content</i>	<i>Possessed time</i>	<i>Related document</i>	
1	SW process basic concept	<ul style="list-style-type: none"> • SW process category • Technical model and meta model • SW process characteristics • System process, software process • SW process improvement • Process inspection, authentication and improvement 	1	8.1	SW process basic concept
2	Quality assurance processes of the organisation	<ul style="list-style-type: none"> • Process infrastructure • Expert group, lower infrastructure and tool • Process implementation and change management model 	2	8.2	Quality assurance processes of the organisation
3	SW process definition	<ul style="list-style-type: none"> • SW development life cycle model • SW development cycle model: waterfall, process typing, incremental, spiral, V model • System life cycle process • Core concept, system life cycle process(convention, project based, project, technical process) • SW life cycle process • Basic, support, organisation life cycle process 	9	8.3	SW process definition
4	SW process evaluation and improvement	<ul style="list-style-type: none"> • SW process evaluation model • Phased representation and continuous representation • CMM, SPICE, SP authentication, ISO 90003 model comparison • Process measurement and evaluation methods • Process inspection modification, index • The level proficiency 0-level proficiency 5 (CMM, SPICE), SP authentication level (1,2,3) • Process development and inspection • Inspection procedure, improvement activities 	10	8.4	SW process evaluation
5	SW engineer measurement process techniques	<ul style="list-style-type: none"> • Measurement process techniques • Batch technique • Bench marking techniques • Process inspection model 	1	8.5	SW measurement

Table 5 Practical educational subject of software measurement and analysis

Section	Education content	Possessed time	Related document
1 SW process and product measurement	<ul style="list-style-type: none"> SW quality types and measurement methods SW process from the perspective of quality measurement SW quality from the perspective of quality measurement The significant of SW quality measurement in the organisation 	1	8.2 Process quality assurance system of the organisation 8.5 SW measurement 9.1 SW quality management concepts
2 Product quality, measurement and analysis	<ul style="list-style-type: none"> PSM SW quality measures and indicators bench marking introduction Quality characteristics of ISO 9126 Quality management model laws SW product quality metrics comparison Analysis comparing the advantages and disadvantages according to the request of the SW product measurements Scale measurement methods and case study introduction Structure determination methods and case study introduction Quality measures method and case study introduction SW measurement metrics practices and case studies Considering the downward SW product quality measurement Configuration SW product quality factors and indicators selection method SW measurement results using mathematical techniques and graphical techniques SW product quality measurement and analysis of benchmarking practices 	4	8.5 SW measurement 8.6 SW process techniques 8.7 SW process tools 9.2 SW management process quality 9.3 SW management techniques quality
3 Process of quality measurement and analysis	<ul style="list-style-type: none"> Introduction to the PSW SW processes and methods of measurement indicators benchmarking practices Comparing quality management model commits SW process measurement standards Comparison the relationship between processes and outcomes Analyse technique The type of technique of the fraud and how to apply The practical of analyse technique SW process measurement under consideration SW process metrics selection method SW process quality measurement results analysis and considerations SW process quality measurement and analysis benchmarking practices 	4	8.2 Process quality assurance system of the organisation 8.4 SW process evaluation 8.6 SW process techniques 8.7 SW process tools 9.2 SW management process quality 9.3 SW management

- 1 The outline of software engineering foundation education subject
- The introduction of curriculum of software engineering and the basic theory and education process in each domain of software engineering knowledge contain the

educational subject content which are shown in Table 3.

- 2 Subjects of software process education
- Software process education subject outline has shown the area subject of the foundation software process

concept, measurement of process, process analysis, processes, and process improvement, etc. It also educates about the process area activity. The educational content is shown in Table 4.

3 Practical educational subject of software measurement and analysis

It is shown about the software enterprise quality manager who is in charge of the quality software product and development project has to understand the type of software quality, the measurement on software product quality, software process quality measurement, etc. (Alavi, 2006). The application of business issues is

educated. The explanation of educational content is shown in Table 5.

4 Practical educational subjects of process

In this subject, the activities regarding enhancement plan for process structure establishment, establishment, process diagnosis and analysis, process design and construction, process establishment and improvement and so on are practiced. This subject educate on utilising methodology and tools through practices. Educational contents are explained in Table 6.

Table 6 Practical educational subject outline of process

<i>Section</i>	<i>Education content</i>	<i>Possessed time</i>	<i>Related document</i>
1 SW process outline	<ul style="list-style-type: none"> SW process types and characteristics SW process development model and diagnostic methods Organisation's process quality assurance system configuration method Organisation of SW process establishment and improvement meaning 	1	8.1 SW process basic concept
2 The organisation of SW formulation process and improvement plans	<ul style="list-style-type: none"> Organisation SW process establishment diagnosis model Benchmarking SW process assessment model case study and analysis SW process establishment and improvement schedule SW process establishment and the improvement schedule considerations 	3	8.3 SW process definition 8.7 SW process tools
3 Diagnosis and analysis of the SW process	<ul style="list-style-type: none"> Modified diagnostic SW process according to the diagnostic model and method SW range of process diagnostic and target selection considerations Estimation method SW process diagnostic criteria and considerations SW method to derive process metrics SW derive process metrics considerations SW process metrics benchmarking case analysis 	4	8.4 SW process evaluation 8.5 SW measurement 8.6 SW process techniques 8.7 SW process tools
4 SW process design and construction	<ul style="list-style-type: none"> AS-IS process design methods and considerations TO-BE process design methods and considerations Process gap analysis methods and considerations Standard SW process extension considerations Organisational considerations SW due to changes in the process SW process design and build a benchmarking analysis of case 	4	8.3 SW process definition 8.6 SW process techniques 8.7 SW process tools
5 SW process of establishing and improving practice pragmatic	<ul style="list-style-type: none"> SW process analysis, establish and improve practices SW process established through a pilot project to apply and improve project practice 	4	8.6 SW process techniques 8.7 SW process tools

3.2 Software engineering process concept

Software quality is the degree of satisfaction on software performance under several conditions of function and performance. Software quality management is the systematic activities to make software meets a specific technological condition, and the methodology and activities necessary for planning, management, and

service and product improvement to satisfy the agreement between the customers and developers (Hmida and Slimani, 2012). The detail contents of software quality knowledge area are explained in Table 7.

Table 7 Detail contents of software quality knowledge area

Knowledge area	Unit subject		Knowledge items		Item details
SW quality	9.1	SW quality management basic concepts	9.1.1	SW quality management defined	<ul style="list-style-type: none"> Definition of quality, quality management definition
			9.1.2	Quality assurance role	<ul style="list-style-type: none"> Elements (annual, processes, techniques, and tools) for quality assurance role
			9.1.3	SW project quality	<ul style="list-style-type: none"> Project warranty ISO 9126, ISO 14598, ISO 12119, ISO 25000 series
			9.1.4	SW process quality	<ul style="list-style-type: none"> Project warranty ISO/IEEE 12207, ISO 15504 (SPICE), CMMs
	9.2	SW quality management process	9.2.1	SW quality management activities	<ul style="list-style-type: none"> SW quality management major activities
			9.2.2	SW quality indicators and quality requirements	<ul style="list-style-type: none"> SW quality characteristics, priorities, trade-offs SW quality requirements
			9.2.3	SW quality assurance costs and planning	<ul style="list-style-type: none"> SW quality assurance costs SW quality assurance plan
			9.2.4	SW quality and quality assurance	<ul style="list-style-type: none"> SW quality control and quality assurance
			9.2.5	SW verification and validation	<ul style="list-style-type: none"> Validation & verification, V & V planning (IEEE 1069)
			9.2.6	Quality Review and Supervision	<ul style="list-style-type: none"> Management review, week review, technical review
			9.2.7	SW defect definition and quality measurement	<ul style="list-style-type: none"> SW defect definition, quality measurement and analyse concept
	9.3	SW quality management techniques	9.3.1	Analytical techniques	<ul style="list-style-type: none"> Batch object technique with the purposes and characteristics
			9.3.2	Static techniques	<ul style="list-style-type: none"> Static techniques and actual techniques
			9.3.3	Manpower-intensive techniques	<ul style="list-style-type: none"> Manpower intensive techniques and actual
			9.3.4	Dynamic techniques and test	<ul style="list-style-type: none"> Dynamic techniques and actual
			9.3.5	Quality metric and measurement	<ul style="list-style-type: none"> Project quality metric and measurement Process quality metric and measurement
	9.4	SW quality management erected issues	9.4.1	SW engineering culture and ethics	<ul style="list-style-type: none"> SW quality culture and elements
			9.4.2	Data quality	<ul style="list-style-type: none"> Data quality and data diagnostic area-based

Table 8 Subjects for each level of software quality education

<i>Level</i> <i>Classification</i>	<i>Introductory course</i>	<i>Intermediate course</i>	<i>Advanced course</i>
Software quality	Software engineering basic	Software quality	Software measurement and analysis of practical Software quality practice

Table 9 Contents of software quality education

<i>Section</i>	<i>Education content</i>	<i>Possessed time</i>	<i>Related document</i>
1 SW quality introduction	<ul style="list-style-type: none"> • SW quality • SDLC and SW quality concern • SW quality introduction 	1	9.1 SW quality management concepts
2 SW quality management concept	<ul style="list-style-type: none"> • SW quality management • Project warranty • ISO 9126, ISO 14598, ISO 12119, ISO 25000 series • ISO/IEEE 12207, ISO 15504 (SPICE), CMMs 	5	9.1 SW quality management concepts
3 SW quality management process	<ul style="list-style-type: none"> • Data quality and data diagnostic area-based • Validation & verification, V & V planning (IEEE 1069) 	5	9.2 SW management process quality
4 SW quality management techniques	<ul style="list-style-type: none"> • SW quality management • SW quality concept and actual • SW quality and analysis • SW quality assurance costs • SW quality assurance plan 	3	9.3 SW management
5 SW quality management erected issues	<ul style="list-style-type: none"> • SW quality culture and elements • Data quality and data diagnostic area-based 	2	9.4 SW quality management and quality requirement

Table 10 Contents of practical education on software quality

<i>Section</i>	<i>Education content</i>	<i>Possessed time</i>	<i>Related document</i>
1 SW quality practical introduction and SW quality	<ul style="list-style-type: none"> • Significance of quality • SW quality management defined • SW quality management process • Element method for quality assurance role • SW project quality • SW process quality 	1	9.1 SW quality management concepts
2 SW quality planning and practice	<ul style="list-style-type: none"> • Product standards and the process of establishing a standard practice • Quality schedule and practice • Quality and quality goal establishment • Means of making quality (process method, standard, rules, etc.) • Concept of SW quality • Evaluation of SW quality • Organisation quality of SW 	3	8.3 SW process definition 8.5 SW measurement 9.2 SW management process quality 9.3 SW management

Table 10 Contents of practical education on software quality (continued)

Section	Education content	Possessed time	Related document
3 SW quality and quality assurance activities and practical	<ul style="list-style-type: none"> • Validation and verification • Review of requirements(SRR), high-level concepts (PDR), TRR and RTS • W quality and assurance 	11	1.6 Requirements validation 2.5 SW design verification 8.4 SW process evaluation 8.5 SW measurement 9.2 SW management process quality 9.3 SW management
4 Defect management practices	<ul style="list-style-type: none"> • Quality analyse and practice • Mathematical technique, cause-effect technique • Defect management and practices • Defect category • Defect data preservation • Defected report 	3	9.2 SW management process quality 9.3 SW management

3.2.1 Educational subject

The educational subject system is divided into three steps according to each of the nine areas classified in the software engineering knowledge list. Educational subjects for each level of software quality area are shown in Table 8.

1 Subject outline for software quality education

In this subject, the concept of software quality, quality related activities and software quality related methodology and tools are majorly focused. The detail contents are shown in Table 9.

2 Subject outline for practical education of software quality

In this subject, education for promoting the ability to apply software quality plan, software quality control and quality warranty using software quality, and defect management by utilising software quality tool, as shown in Table 10.

4 Conclusions

This paper presents the framework for skill, knowledge and training relating to software engineering, which is important for software industry and education field to increase the productivity of quality and development of domestic software industry. Among these, it explains educational contents about software process and software quality. In order to foster a good software engineering systematic training programme is required for each learn. This guideline is currently using at undergraduate, graduate of software engineering class as pilot programme. In the future, software engineering standard curriculum can be expected, and software developers can refer to it as a guideline.

Acknowledgements

This research was supported by the MSIP (Ministry of Science, ICT and Future Planning), Korea, under the IT/SW Creative research program supervised by the NIPA (National IT Industry Promotion Agency) (NIPA-20130170).

References

- Alavi, B. (2006) *Distance Measurement Error Modeling for Time-of-Arrival Based Indoor Geolocation*, PhD dissertation, Worcester Polytechnic Institute, MA.
- Hmida, M.B.H. and Slimani, Y. (2012) 'Improving classification accuracy using code migration', *IJAST*, January, Vol. 38, pp.25–36.
- Jones, J. (1991) *Networks*, 2nd ed., 10 May [online] <http://www.atm.com>.
- Lee, S. (2012) 'Test case design for software database provisioning development', *IJAST*, December, Vol. 49, pp.92–104.
- Macia-Prez, F. et al. (2012) 'A new paradigm: cloud agile manufacturing', *IJAST*, August, Vol. 45, pp.47–54.
- Proakis, J.G. and Salehi, M. (1993) *Digital Communications*, 5th ed., pp.123–135, McGraw-Hill, New York.
- Vidmar, R.J. (1992) 'On the use of atmospheric plasmas as electromagnetic reflectors', *IEEE Trans. Plasma Sci.*, August, Vol. 21, No. 3, pp.876–880 [online] <http://www.halcyon.com/pub/journals/21ps03-vidmar>.
- Yorozu, Y., Hirano, M., Oka, K. and Tagawa, Y. (1987) 'Electron spectroscopy studies on magneto-optical media and plastic substrate interfaces', *IEEE Trans. Commun.*, August, Vol. 52, No. 3, pp.740–741.