A revision of the knowledge classification in three SWEBOK chapters: Management, Process and Quality

LUIGI BUGLIONE **ALAIN ABRAN**

École de Technologie Supérieure - ETS
1100 Notre-Dame Ouest,
Montréal, Canada H3C 1K3

E-mail: luigi.buglione@computer.org
Tel: (39) 338.95.46.917
Fax: (39) 06-8307.4200

E-mail: aabran@ele.etsmtl.ca
Tel: +1 (514) 396-8632
Fax: +1 (514) 396-8684

Position Paper

One of the editorial specification (Criteria no. 2.3) for the design of the SWEBOK Guide was the determination, for each topic within all Knowledge Area (KA), of the expected level of knowledge for *"a graduate plus four years of experience"*. The levels of knowledge were to be described using the classification of knowledge using Bloom's taxonomy which is well known in the field of pedagogy. In the 2001 Trial version 1.0 of the Guide, most of the ten KAs have been classified using this taxonomy.

The scope of this position paper is to propose a review and an update for three KA: Software Engineering Management, Software Engineering Process and Software Quality. The motivation for the selection of these three KA is due to two commonalities they share:

- They are strongly related through measurement issues;
- They are all "secondary" processes (and KA) in the software life cycle, as described in ISO/IEC 12207 classification

A preliminary review is presented in Tables 1 to 3, including the current classification level and the proposed one with related comments. When a cell in the proposed "Level " column is empty, no revision is deemed necessary.

Some problems and/or ambiguities were noted in revising the actual classification proposed in the 2001 edition

1. Some ratings across KA are not consistent. For instance, within KA.07 – Software Engineering Management, the B1 topic (Determination and Negotiation of requirements) presents a rating different from what found out in the KA.01 – Requirements Management.
2. The targeted audience, *"a graduate plus four years of experience*", for the classification is not homogeneous in terms of work experience, and it is challenging to determine a single level of knowledge independently of the context. . For instance, after 4 years of experience, a junior software engineer mightnot have had the opportunity to work on all 10 Kas - he might have worked in development projects or in maintenance, or he might have been lucky to work in 'process improvement groups'.

Therefore, the levels of knowledge across all 10 KA could vary considerably one by one, on the basis of the experience gained.
For practical purposes, it might be more relevant to determine ne not just one Bloom,s classification table for each KA, but multiple ones such as:

- A table of levels expected from a *new graduate* from a University program (and without experience).
- A table of levels expected from a *software engineer who has worked in software development/maintenance* and claims recognized expertise in a specific KA (in which he has worked from 1 to 4 years).
- A table of levels expected from a *software engineer who has worked in softare process improvement.*

We therefore proposedthree draft of revisions for KA.07, KA.08 and KA.10, segregated by the three levels of experience identified above.

Experience: *New Graduate from University with no experience*

Table 1: KA.07 – Software Engineering Management

Topic	Level (Actual)	Level (Proposed)	Comments
A. Organizational Management			
Policy Management	2 – comprehension		
Personnel Management	4 – analysis	2 – comprehension	some tips on People CMM, for instance
Communication Management	4 – analysis	2 – comprehension	some tips on People CMM, for instance
Portfolio Management	2 – comprehension		
Procurement Management	1 – knowledge	2 – comprehension	Recommended 'comprehension' since a . + 4 years is sometimes an active participant
B. Project/Process Management			
Determination & Negotiation of requirements	2 – comprehension		
Feasibility Analysis	3 – application		
Review / Revision of requirements	2 – comprehension		
Process Planning	4 – analysis	3 – application	Maybe here it could be sufficient a lower knowledge and usage than stated in the actual rating
Project Planning	3 – application		
Determine Deliverables	2 – comprehension	3 – application	Maybe here it could be sufficient a lower knowledge and usage than stated in the actual rating
Effort, Schedule, and cost determination	4 – analysis	3 – application	Maybe here it could be sufficient a lower knowledge and usage than stated in the actual rating.
Resource Allocation	3 – application		
Risk Management	5 - synthesis	4 – analysis	Maybe here it could be sufficient a lower knowledge and usage than stated in the actual rating
Quality Management	5 – synthesis	4 – analysis	Maybe here it could be sufficient a lower knowledge and usage than stated in the actual rating
Plan Management	3 – application		
Implementation of Plans	3 – application		
Implementation of Measurement process	3 – application		
Monitor process	3 – application		
Control process	3 – application		
Reporting	3 – application		
Determining satisfaction of requirements	2 – comprehension		
Reviewing and evaluating performance	3 – application		
Determining closure	3 – application		
Closure activities	2 – comprehension		
C. Software Engineering Measurement			

Organizational objectives	5 – synthesis	2 – comprehension	Maybe here it could be sufficient a lower knowledge and usage than stated in the actual rating, in particular about company strategies and policies.
Software Process Improvement goals	5 – synthesis	2 – comprehension	Maybe here it could be sufficient a lower knowledge and usage than stated in the actual rating, in particular about company strategies and policies.
Goal-driven measurement selection	3 – application		
Measurement validity	2 – comprehension		
Size Measurement	4 – analysis	3 – application	It should be requested something more practical to this kind of professional figures, as a concrete FPA counting
Structure Measurement	4 – analysis	3 – application	The same comment as above
Resource Measurement	4 – analysis	3 – application	The same comment as above
Quality Measurement	4 – analysis	3 – application	The same comment as above
Survey techniques and form design	1 – knowledge		
Automated and manual data collection	1 – knowledge		
Model building, calibration & evaluation	3 – application	2 – comprehension	According to the lower level in the several measurement activities, also here in the calibration issue, the comprehension should be sufficient
Implementation, Interpretation & refinement of models	4 – analysis	2 – comprehension	According to the lower level in the several measurement activities, also here in the calibration issue, the comprehension should be sufficient. An analysis level could be out of scope for that kind of people.

Table 2: KA.08 – Software Engineering Process

Topic	Level (Actual)	Level (Proposed)	Comments
A. Software Engineering Process Concepts			
Themes	2 – comprehension		
Terminology	1 – knowledge		
B. Process Infrastructure			
The Software Engineering Process Group	2 – comprehension		
The Experience Factory	2 – comprehension		
C. Process Measurement			
Methodology in Process Measurement	2 – comprehension		
Process Measurement Paradigms	2 – comprehension		
* Analytic Paradigm	2 – comprehension		
* Benchmarking Paradigm	2 – comprehension		
D. Process Definition			
Types of Process Definitions	3 – application	2 – comprehension	Maybe here it could be sufficient a lower knowledge and usage than stated in the actual rating
Life Cycle Framework Models	3 – application	2 – comprehension	Maybe here it could be sufficient a lower knowledge and usage than stated

			in the actual rating
Software Life Cycle Process Models	3 – application	2 – comprehension	Maybe here it could be sufficient a lower knowledge and usage than stated in the actual rating
Notations for process defitinions	3 – application	2- Comprehension	Maybe here it could be sufficient a lower knowledge and usage than stated in the actual rating
Process Definition Models	3 – application	2- Comprehension	Maybe here it could be sufficient a lower knowledge and usage than stated in the actual rating
Automation	1 – knowledge	2 – comprehension	As stated also for tools in the "Software Engineering Management" KA, at least, the usage of automated tools has to be comprehended, not simply known.
E. Qualitative Process Analysis			
Process Definition Review	2 – comprehension		
Root Cause Analysis	2 – comprehension	3 – application	The output of an RCA (also called Fishbone or Ishikawa diagram) is a deeper analysis on root causes for a problem. It is not sufficient the comprehension of a mechanism, but its removal after detecting the initial cause, at least the application
F. Process Implementation & Change			
Paradigms for Process Implementation & Change	2 – comprehension		
Guidelines for Process Implementation & Change	2 – comprehension		
Evaluating the Outcome of Process Implementation & Change	2 – comprehension		

Table 3: KA.10 – Software Quality

Topic	Level (Actual)	Level (Proposed)	Comments
	a) Software Engineer b) SQA/V&V c) Project Mgr		
Software Quality Concepts			
Measuring the value of Quality	2 – comprehension 2 – comprehension 4 – analysis	= = 3 – application	Maybe here it could be sufficient a lower knowledge and usage than stated in the actual rating
ISO 9126 Quality Description	2 – comprehension 2 – comprehension 2 – comprehension		
Dependability	2 – comprehension 2 – comprehension 2 – comprehension		
Special Types of Systems and Quality Needs	2 – comprehension 2 – comprehension 2 – comprehension		
Purpose and Planning of SQA and V&V			
Common Planning Activities			
The SQA Plan	3 – application 5 – synthesis 6 - evaluation	2 – comprehension 3 – application 4 – analysis	Here a programmer have to simply follow the indications on a SQA plan, while a SQA/V&V people and PMs maybe can have a bit lower knowledge of this topic. A general problem is to align the Bloom rating on topics where there is a review and analysis activity. Here it seems higher than in other KAs.
The V&V Plan	3 – application 5 – synthesis 6 - evaluation	2 – comprehension 3 – application 4 – analysis	Same comment than the previous item
Activities and Techniques for SQA and V&V			
Static Techniques			
Audits, Reviews and Inspections	3 – application 6 – evaluation 4 - analysis	= 4 - analysis =	As in the previous two items, it seems that an SQA/V&V people should remain to a lower ratio level
Analysis Techniques	3 – application 6 – evaluation 4 - analysis	= 4 - analysis =	Same comment than the previous item
Dynamic Techniques	3 – application 6 – evaluation 4 - analysis	= 4 - analysis =	Same comment than the previous item

Measurement applied to SQA and V&V			
Fundamentals of Measurement	3 – application 6 – evaluation 4 - analysis	= 3 – application 4 – analysis	SQA/V&V and PM need to have the same level of knowledge, even if with different final scopes.
Measures	3 – application 6 – evaluation 4 - analysis	= 3 – application 4 – analysis	Same comment than the previous item
Measurement Analysis Techniques	3 – application 6 – evaluation 4 - analysis	= 3 - application =	Same comment than for the Static techniques
Defect characterization	3 – application 6 – evaluation 4 - analysis	= 3 - application =	For this people, the application level in the SQA/V&V position is right
Additional Uses of SQA and V&V data	3 – application 6 – evaluation 4 - analysis	= 4 - analysis =	For this people, the analysis level in the SQA/V&V position is right, since implying yet the organized usage of data

Experience: *Software Engineer working in software development/maintenance*

Table 1: KA.07 – Software Engineering Management

Topic	Level (Actual)	Level (Proposed)	Comments
A. Organizational Management			
Policy Management	2 – comprehension	3 – application	As said in section A1, "it is important that those charged with the management of SwEng both understand and influence the development, dissemination, deployment and enforcement of policies and standards". It seems the simple comprehension is lower than asked directly in the text from the KA Champion.
Personnel Management	4 – analysis		
Communication Management	4 – analysis		
Portfolio Management	2 – comprehension	3 – application	The points stressed in A4 as "Project Selection" imply a further step beyond than simple comprehension of problems. They have to take decisions.
Procurement Management	1 – knowledge	2 – comprehension	since a Bacc. + 4 years is sometimes an active participant
B. Project/Process Management			
Determination & Negotiation of requirements	2 – comprehension	3 – application	Two different levels for two KA: here level 2, in the "Requirement" KA level four. To be harmonized since the same topic. At least level 3 (application)
Feasibility Analysis	3 – application		
Review / Revision of requirements	2 – comprehension	3 – application	Same comment than for "Determination & Negotiation of Requirements"
Process Planning	4 – analysis		
Project Planning	3 – application		
Determine Deliverables	2 – comprehension	3 – application	It wouldn't be sufficient the simple comprehension, even if the practical application of such knowledge for determining the number and kind of project deliverable
Effort, Schedule, and cost determination	4 – analysis		
Resource Allocation	3 – application		
Risk Management	5 - synthesis	4 – analysis	Lower for that category
Quality Management	5 – synthesis	4 – analysis	Lower for that category
Plan Management	3 – application		
Implementation of Plans	3 – application		
Implementation of Measurement process	3 – application		
Monitor process	3 – application		
Control process	3 – application	4 – analysis	This is a process that implies an accurate analysis of what occured in order to "accomodate the unexpected outcomes and their flow-on implications".
Reporting	3 – application		

Determining satisfaction of requirements	2 – comprehension	3 – application	As for "Determination & Negotiation of Requirements", here it is needed tha capability of people of acting when variances from expectations are identified. More than the comprehension of the problem occured.
Reviewing and evaluating performance	3 – application	4 – analysis	Same comment than "Control Process". One of the keyword associated to the "Analysis" rating level is just "compare"
Determining closure	3 – application		
Closure activities	2 – comprehension		
C. Software Engineering Measurement			
Organizational objectives	5 – synthesis	3 – application	More operative knowledge
Software Process Improvement goals	5 – synthesis	3 – application	More operative knowledge
Goal-driven measurement selection	3 – application		
Measurement validity	2 – comprehension	3 – application	According the text in the Guide, "an awareness of issues relating to measurement validity and reliability is essential if the measurement program is to provide effective and bounded results". Therefore, it is appropriate to fix a rating level at least not lower than the one for the previous issue (Goal-Driven measurement selection), rated to 3 – Application.
Size Measurement	4 – analysis		
Structure Measurement	4 – analysis		
Resource Measurement	4 – analysis		
Quality Measurement	4 – analysis		
Survey techniques and form design	1 – knowledge	2 – comprehension	A bit more in the rating, since it should not be sufficient to write and create a form, even if to exactly know how a form could be conveniently wrote in order to extract the better and more complete information as possible from interviewed people.
Automated and manual data collection	1 – knowledge	2 – comprehension	At least, also the collection procedure has to be comprehended, not simply known.
Model building, calibration & evaluation	3 – application	4 – analysis	At least, this issue and the next one must be aligned in terms of rating
Implementation, Interpretation & refinement of models	4 – analysis		

Table 2: KA.08 – Software Engineering Process

Topic	Level (Actual)	Level (Proposed)	Comments
A. Software Engineering Process Concepts			
Themes	2 – comprehension		
Terminology	1 – knowledge	2 – comprehension	For practical usage
B. Process Infrastructure			
The Software Engineering Process Group	2 – comprehension	3- application	The application level is needed in order to be actively part of an SEPG in the organization, according to the previous experience for such people

The Experience Factory	2 – comprehension	3 – application	To introduce an EF into a company should stress more and more its applicative side, since several experience packages can be managed and knowledge has to be re-arranged each time for reusing as much as possible from past experience.
C. Process Measurement			
Methodology in Process Measurement	2 – comprehension	3 – application	Since GQM was rated 3 – application in the "Software Engineering management" KA, for sake of uniformity, it would be appropriate to align the two.
Process Measurement Paradigms	2 – comprehension	3- Application	An application level is required for an experienced people, not sufficient the basic comprehension of mechanisms
* Analytic Paradigm	2 – comprehension	3- Application	The same as above
* Benchmarking Paradigm	2 – comprehension	3- Application	The same as above
D. Process Definition			
Types of Process Definitions	3 – application		
Life Cycle Framework Models	3 – application		
Software Life Cycle Process Models	3 – application		
Notations for process defitinions	3 – application	2- Comprehension	Maybe here it could be sufficient a lower knowledge and usage than stated in the actual rating
Process Definition Models	3 – application	2- Comprehension	Maybe here it could be sufficient a lower knowledge and usage than stated in the actual rating
Automation	1 – knowledge	2 – comprehension	As stated also for tools in the "Software Engineering Management" KA, at least, the usage of automated tools has to be comprehended, not simply known.
E. Qualitative Process Analysis			
Process Definition Review	2 – comprehension	3- application	An application level is required for an experienced people, not sufficient the basic comprehension of mechanisms
Root Cause Analysis	2 – comprehension	3- application	The output of an RCA (also called Fishbone or Ishikawa diagram) is a deeper analysis on root causes for a problem. It is not sufficient the comprehension of a mechanism, but its removal after detecting the initial cause.
F. Process Implementation & Change			
Paradigms for Process Implementation & Change	2 – comprehension		
Guidelines for Process Implementation & Change	2 – comprehension	3 – application	IDEAL or QIP have to be practically implemented, not simply catching the information for eventual future usage.
Evaluating the Outcome of Process Implementation & Change	2 – comprehension	4 – analysis	Evaluation for reuse past experience needs a rating to level 4

Table 3: KA.10 – Software Quality

Topic	Level (Actual)	Level (Proposed)	Comments
	d) Software Engineer e) SQA/V&V f) Project Mgr		
Software Quality Concepts			
Measuring the value of Quality	2 – comprehension 2 – comprehension 4 – analysis	= 4 – analysis =	At least the SQA/V&V people has to analyze what occurs with the customer in establishing qualitative levels for the project, on the base of past experiences, not simply to let the Project Manager will manage for his own this task
ISO 9126 Quality Description	2 – comprehension 2 – comprehension 2 – comprehension	= 3 – application 4 – analysis	About this standard, a greater number of bids require to respect in a certain way some qualitative level for the project. New revision for this ISO standard, including also metrics for internal, external and in use quality have to be practically applied for a quantitative management of requirements, in particular the non-functional ones.
Dependability	2 – comprehension 2 – comprehension 2 – comprehension	= 3- analysis 5 – synthesis	A project manager, even young, needs to have the capability to recognize and re-arrange the system to manage when "extremely severe consequences" can occur. It is not sufficient he/she simply knows what can happen. The risk has to be properly managed.
Special Types of Systems and Quality Needs	2 – comprehension 2 – comprehension 2 – comprehension	===	Quality characteristics not listed in ISO 9126, as stated in the guide, refer to some practical items such as reusability, where all the three job responsibilities have to be aligned in terms of knowledge. Programmers have to apply this knowledge to projects.
Purpose and Planning of SQA and V&V			
Common Planning Activities			
The SQA Plan	3 – application 5 – synthesis 6 - evaluation	2 – comprehension 4 – analysis 5 – synthesis	Here a programmer have to simply follow the indications on a SQA plan, while a SQA/V&V people and PMs maybe can have a bit lower knowledge of this topic. A general problem is to align the Bloom rating on topics where there is a review and analysis activity. Here it seems higher than in other KAs.
The V&V Plan	3 – application 5 – synthesis 6 - evaluation	2 – comprehension 4 – analysis 5 – synthesis	Same comment than the previous item
Activities and Techniques for SQA and V&V			
Static Techniques			
Audits, Reviews and Inspections	3 – application 6 – evaluation 4 - analysis	= 5 – synthesis =	As in the previous two items, it seems that an SQA/V&V people should remain to a lower ratin level
Analysis Techniques	3 – application 6 – evaluation	= 5 – synthesis	Same comment than the previous item

	4 - analysis	=	
Dynamic Techniques	3 – application 6 – evaluation 4 - analysis	= 5 – synthesis =	Same comment than the previous item
Measurement applied to SQA and V&V			
Fundamentals of Measurement	3 – application 6 – evaluation 4 - analysis	= 5 – synthesis 5 - synthesis	SQA/V&V and PM need to have the same level of knowledge, even if with different final scopes.
Measures	3 – application 6 – evaluation 4 - analysis	= 5 – synthesis 5 - synthesis	Same comment than the previous item
Measurement Analysis Techniques	3 – application 6 – evaluation 4 - analysis	= 5 – synthesis =	Same comment than for the Static techniques
Defect characterization	3 – application 6 – evaluation 4 - analysis		
Additional Uses of SQA and V&V data	3 – application 6 – evaluation 4 - analysis		

Experience: *Software Engineer working in Process Improvement*

Table 1: KA.07 – Software Engineering Management

Topic	Level (Actual)	Level (Proposed)	Comments
A. Organizational Management			
Policy Management	2 – comprehension	3 – application	As said in section A1, "it is important that those charged with the management of SwEng both understand and influence the development, dissemination, deployment and enforcement of policies and standards". It seems the simple comprehension is lower than asked directly in the text from the KA Champion.
Personnel Management	4 – analysis		
Communication Management	4 – analysis		
Portfolio Management	2 – comprehension	3 – application	The points stressed in A4 as "Project Selection" imply a further step beyond than simple comprehension of problems. They have to take decisions. Same comment as above.
Procurement Management	1 – knowledge	3 – application	Active role to dialogue with Procurement Department
B. Project/Process Management			
Determination & Negotiation of requirements	2 – comprehension	3 – application	Two different levels for two KA: here level 2, in the "Requirement" KA level four. To be harmonized since the same topic. At least level 3 (application)
Feasibility Analysis	3 – application		
Review / Revision of requirements	2 – comprehension	3 – application	Same comment than for "Determination & Negotiation of Requirements"
Process Planning	4 – analysis		
Project Planning	3 – application		
Determine Deliverables	2 – comprehension	3 – application	It wouldn't be sufficient the simple comprehension, even if the practical application of such knowledge for determining the number and kind of project deliverable
Effort, Schedule, and cost determination	4 – analysis		
Resource Allocation	3 – application		
Risk Management	5 - synthesis	4 – analysis	A SPI people would be leveled at the analysis level, at least
Quality Management	5 – synthesis	4 – analysis	A SPI people would be leveled at the analysis level, at least
Plan Management	3 – application	5 – synthesis	The synthesis is needed for managing the plan, in particular for the skills of an SPI people, since that synthesis represents the basis for the continuous improvement
Implementation of Plans	3 – application	4 – analysis	The same comment than above: the simple application wouldn't be sufficient for make concrete the continuous improvement actions
Implementation of Measurement process	3 – application	4 – analysis	The same comment than above: the simple application wouldn't be

			sufficient for make concrete the continuous improvement actions
Monitor process	3 – application	4 – analysis	The same comment than above: the simple application wouldn't be sufficient for make concrete the continuous improvement actions
Control process	3 – application	4 – analysis	This is a process that implies an accurate analysis of what occured in order to "accomodate the unexpected outcomes and their flow-on implications".
Reporting	3 – application		
Determining satisfaction of requirements	2 – comprehension	3 – application	As for "Determination & Negotiation of Requirements", here it is needed tha capability of people of acting when variances from expectations are identified. More than the comprehension of the problem occured.
Reviewing and evaluating performance	3 – application	4 – analysis	Same comment than "Control Process". One of the keyword associated to the "Analysis" rating level is just "compare"
Determining closure	3 – application		
Closure activities	2 – comprehension	3 – application	At least, those activities have to be applied, not simply comprehended
C. Software Engineering Measurement			
Organizational objectives	5 – synthesis	6 - evaluation	From a strategical viewpoint, an SPI people is one of the more focused people on strategical and tactical items
Software Process Improvement goals	5 – synthesis		
Goal-driven measurement selection	3 – application	4 – analysis	The analysis is the minimum level from about the selection of indicators, according to the previous item (SPI goals). From the proper indicators selection, it will be possible to derive the real useful info on the project/organization trends
Measurement validity	2 – comprehension	4 – analysis	According the text in the Guide, "an awareness of issues relating to measurement validity and reliability is essential if the measurement program is to provide effective and bounded results". Therefore, it is appropriate to fix a rating level at least not lower than the one for the previous issue (Goal-Driven measurement selection), rated to 3 – Application.
Size Measurement	4 – analysis		
Structure Measurement	4 – analysis		
Resource Measurement	4 – analysis		
Quality Measurement	4 – analysis	5 – synthesis	Needed a greater capability for those people
Survey techniques and form design	1 – knowledge	3 – application	A bit more in the rating, since it should not be sufficient to write and create a form, even if to exactly know how a form could be conveniently wrote in order to extract the better and more complete information as possible from interviewed people.
Automated and manual data collection	1 – knowledge	4 – analysis	At least, also the collection procedure has to be comprehended, not simply known.
Model building, calibration & evaluation	3 – application	4 – analysis	At least, this issue and the next one must be aligned in terms of rating
Implementation, Interpretation & refinement of models	4 – analysis	5 – synthesis	Subsequent to the data gathering

Table 2: KA.08 – Software Engineering Process

Topic	Level (Actual)	Level (Proposed)	Comments
A. Software Engineering Process Concepts			
Themes	2 – comprehension	3- application	A practical application of concepts is needed, from experience, in order to be reused
Terminology	1 – knowledge	2 – comprehension	At least the comp rehension must be required, also about terminology
B. Process Infrastructure			
The Software Engineering Process Group	2 – comprehension	3- application	
The Experience Factory	2 – comprehension	3 – application	To introduce an EF into a company should stress more and more its applicative side, since several experience packages can be managed and knowledge has to be re-arranged each time for reusing as much as possible from past experience.
C. Process Measurement			
Methodology in Process Measurement	2 – comprehension	3 – application	Since GQM was rated 3 – application in the "Software Engineering management" KA, for sake of uniformity, it would be appropriate to align the two.
Process Measurement Paradigms	2 – comprehension	3- Application	An application level is required for an experienced SPI people, not sufficient the basic comprehension of mechanisms
* Analytic Paradigm	2 – comprehension	3- Application	The same as above
* Benchmarking Paradigm	2 – comprehension	3- Application	The same as above
D. Process Definition			
Types of Process Definitions	3 – application		
Life Cycle Framework Models	3 – application		
Software Life Cycle Process Models	3 – application		
Notations for process defitinions	3 – application		
Process Definition Models	3 – application		
Automation	1 – knowledge	3 – application	As stated also for tools in the "Software Engineering Management" KA, at least, the usage of automated tools has to be practically applied, not simply known.
E. Qualitative Process Analysis			
Process Definition Review	2 – comprehension	3 – application	An application level is required for an experienced SPI people, not sufficient the basic comprehension of mechanisms
Root Cause Analysis	2 – comprehension	5 – synthesis	The output of an RCA (also called Fishbone or Ishikawa diagram) is a deeper analysis on root causes for a problem. It is not sufficient the comprehension of a mechanism, but its removal after detecting the initial cause.
F. Process Implementation & Change			
Paradigms for Process Implementation & Change	2 – comprehension		

Guidelines for Process Implementation & Change	2 – comprehension	3 – application	IDEAL or QIP have to be practically implemented, not simply catching the information for eventual future usage.
Evaluating the Outcome of Process Implementation & Change	2 – comprehension	4 – analysis	Evaluation for reuse past experience needs a rating to level 4

Table 3: KA.10 – Software Quality

Topic	Level (Actual)	Level (Proposed)	Comments
	g) Software Engineer h) SQA/V&V i) Project Mgr		
Software Quality Concepts			
Measuring the value of Quality	2 – comprehension 2 – comprehension 4 – analysis	= 4 – analysis =	At least the SQA/V&V people has to analyze what occurs with the customer in establishing qualitative levels for the project, on the base of past experiences, not simply to let the Project Manager will manage for his own this task
ISO 9126 Quality Description	2 – comprehension 2 – comprehension 2 – comprehension	3 – application 4 – analysis =	About this standard, a greater number of bids require to respect in a certain way some qualitative level for the project. New revision for this ISO standard, including also metrics for internal, external and in use quality have to be practically applied for a quantitative management of requirements, in particular the non-functional ones.
Dependability	2 – comprehension 2 – comprehension 2 – comprehension	3- analysis 4 - analysis 5 – synthesis	A project manager, even young, needs to have the capability to recognize and re-arrange the system to manage when "extremely severe consequences" can occur. It is not sufficient he/she simply knows what can happen. The risk has to be properly managed.
Special Types of Systems and Quality Needs	2 – comprehension 2 – comprehension 2 – comprehension	= 3 5 - synthesis	Quality characteristics not listed in ISO 9126, as stated in the guide, refer to some practical items such as reusability, where all the three job responsibilities have to be aligned in terms of knowledge. Programmers have to apply this knowledge to projects.
Purpose and Planning of SQA and V&V			
Common Planning Activities			
The SQA Plan	3 – application 5 – synthesis 6 - evaluation		
The V&V Plan	3 – application 5 – synthesis 6 - evaluation		
Activities and Techniques for SQA and V&V			
Static Techniques			
Audits, Reviews and Inspections	3 – application 6 – evaluation 4 - analysis	= 5 – synthesis =	As in the previous two items, it seems that an SQA/V&V people should remain to a lower ratio level
Analysis Techniques	3 – application 6 – evaluation 4 - analysis	= 5 – synthesis =	Same comment than the previous item

Dynamic Techniques	3 – application 6 – evaluation 4 - analysis	= 5 – synthesis =	Same comment than the previous item
Measurement applied to SQA and V&V			
Fundamentals of Measurement	3 – application 6 – evaluation 4 - analysis	= 5 – synthesis 5 - synthesis	SQA/V&V and PM need to have the same level of knowledge, even if with different final scopes.
Measures	3 – application 6 – evaluation 4 - analysis	= 5 – synthesis 6 – evaluation	Same comment than the previous item. The PM has to replan the project according to results.
Measurement Analysis Techniques	3 – application 6 – evaluation 4 - analysis	= 5 – synthesis 4 - analysis	Same comment than for the Static techniques
Defect characterization	3 – application 6 – evaluation 4 - analysis		
Additional Uses of SQA and V&V data	3 – application 6 – evaluation 4 - analysis		