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Information technology — Learning, education and training — Quality management, assurance and metrics —

Part 3: Reference methods and metrics

Technologies de l'information — Apprentissage, éducation et formation — Management, assurance et métrologie de la qualité —

Partie 3: Méthodes de référence et métrologie

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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ISO/IEC 19796-3 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 36, *Information technology for learning, education and training*.

ISO/IEC 19796 consists of the following parts, under the general title *Information technology — Learning, education and training — Quality management, assurance and metrics*:

— *Part 1: General approach*

— *Part 3: Reference methods and metrics*

The following parts are under preparation:

— *Part 2: Harmonized quality model*

— *Part 4: Best practice and implementation guide* [Technical Report]

— *Part 5: How to use ISO/IEC 19796-1* [Technical Report]

Introduction

Quality in the field of distance education and e-learning has become an issue of increasing importance in academia, institutions, and industry. A variety of approaches have been developed and implemented successfully. Generic standards, such as ISO 9000:2005 and/or ISO 14000 have been used also in the educational community. In addition to generic standards related to quality, there are specific quality guidelines that have been developed and used for e-Learning or distance education (such as the ASTD criteria for e-Learning, the BLA Quality Mark, Quality Platform Learning by D-ELAN, or Quality elements by Sloan-consortium). It has become clear that quality management can contribute to improve the performance of organizations in the field of learning, education, and training (LET).

Numerous approaches to quality management and assurance and their different scopes and objectives lead to confusion within communities that depend on information technologies to support and facilitate learning, education, and training. Therefore, a harmonized quality standard, the ISO/IEC 19796 series, has been developed.

ISO/IEC 19796 has five parts as a series. ISO/IEC 19796-1 is the basic framework for quality development in organizations within the field of learning, education, and training (LET). It serves as a framework to describe, compare, and analyze quality management and quality assurance approaches. In addition to providing a descriptive model that can be used to compare and analyze quality approaches, ISO/IEC 19796-1 identifies the components of a seven-part process model within the lifecycle of information and communication systems for learning, education, and training. As a framework it may be used to compare different quality assurance and quality management processes. This part of ISO/IEC 19796 provides reference methods and metrics used in the lifecycle process. It also provides examples of how methods and metrics can be generically described, compared, and used for specific contexts. For each process in the e-learning lifecycle, a set of potential methods and metrics should be specified. This set of methods and metrics can be used during the development of an individual quality approach that is based on defined quality objectives.

ISO/IEC 19796-1 describes the processes for the e-Learning lifecycle. It is a reference model with a high level of abstraction which has to be adapted to a certain organization and to a certain situation. To facilitate the adaptation procedure, two reference models for quality management and quality assurance are described in this part of ISO/IEC 19796:

— reference model for methods;

— reference model for metrics.

To facilitate the adaptation of ISO/IEC 19796-1, as the first step, this part of ISO/IEC 19796 provides reference methods and metrics used in lifecycle processes with the reference models from ISO/IEC 19796-1. It also provides collections of methods and metrics which are generically described and can be used for specific contexts. For each process in the e-Learning lifecycle, a set of potential methods and metrics should be specified. This set of methods and metrics can be used during the development and definition of an individual quality approach based on certain quality objectives.

ISO/IEC 19796-1 provides a description format and a process framework as the reference framework for the description of quality approaches (RFDQ), for the description and development of quality approaches. The RFDQ framework is only a base for quality development – it does not provide specific methods and metrics for particular quality objectives, and also does not provide instruments or procedures.

ISO Guide 72 Guidelines mainly distinguish three types of management system standards; Type A — management systems requirements standards, Type B — management systems guidelines standards, and Type C — management systems related standards. The consensus is to use *ISO Guide 72 Guidelines for the justification and development of management system standards*. Accordingly, this International Standard is Type C, a management systems related standard, as neither requirements are defined nor guidelines are given.

Information technology — Learning, education and training — Quality management, assurance and metrics —

Part 3: Reference methods and metrics

1 Scope

This part of ISO/IEC 19796 extends the "reference framework for the description of quality approaches" (RFDQ) defined in ISO/IEC 19796-1 by providing a harmonized description of the methods and metrics required to implement quality management and quality assurance systems for stakeholders designing, developing, or utilizing information technology systems used for learning, education, and training.

Activities such as quality planning, quality control, and quality improvement are important for quality management implementations. While these three activities are focused on products, processes and their development, quality assurance is focused more on confirmation and indication for internal and external stakeholders. It should be noted that the reference methods and metrics for this part of ISO/IEC 19796 include issues related to the implementation of quality management and assurance systems for information technologies that are used for learning, education, and training. This part of ISO/IEC 19796 is to be used to help identify methods and metrics to implement a quality assurance and management system of an IT system used for learning, education, and training. For example, it may be used for quality management systems that help to verify items such as IT system effectiveness, compliance with quality objectives including purposes, customer satisfaction, training in the use of the IT system, complaints handling, and auditing.

NOTE While not included in the normative references of this part of ISO/IEC 19796 it may be helpful for ITLET (Information Technology for Learning, Education, and Training) stakeholders interested in quality issues to refer to the related standards listed in the bibliography for further information regarding quality management and quality assurance.

During the implementation of quality management and quality assurance systems, using specific methods and metrics are indispensable for the exchange, purchase, management, and archiving of learning courses, systems, and/or services. Involving all stakeholders (e.g., developers, administrators, government, providers, teachers, and learners) within a framework that is open and inclusive will help to ensure that information technologies for learning, education, and training are both effective for and appropriate to learning and teaching needs.

This part of ISO/IEC 19796 has the following components, which are developed in order to indicate and communicate quality approaches.

- The reference model for methods — provides an interoperable formalized description of methods that can be easily implemented and adopted into a quality management system to realize and facilitate quality management.
- The reference model for metrics — provides an interoperable formalized description of metrics that can be easily implemented and adopted into a quality management system to measure quality in a comparable way.
- A collection of methods that can be used to manage and assure quality in different contexts. It supports stakeholders to implement concrete actions to achieve (a set of) quality objectives.

- A collection of metrics and indicators that can be used to measure quality in processes, products, components, and services. It supports stakeholders to implement measures (e.g. indicators) for specific quality objectives.

- Annex A (informative) contains examples of how this part of ISO/IEC 19796 can be used and provides a suggested format to describe a quality method.

- Annex B (informative) contains examples of how this part of ISO/IEC 19796 can be used and provides a suggested format to describe a quality metric.

2 Conformance

The objective of this part of ISO/IEC 19796 is to extend the RFDQ (defined by ISO/IEC 19796-1) leading to a complete quality system that supports stakeholders to implement quality management and quality assurance systems.

For each quality management and assurance process a set of potential methods and metrics that can be used at the development of individual quality approaches needs to be specified. The harmonized description of these methods and metrics is needed to provide clear understanding, mutual communication and agreement. The collections of methods and metrics such as quality approaches should be extensible.

A method or metric is conformant if it uses the corresponding reference model (i.e. Clause 7 for methods and Clause 8 for metrics) or an instantiation in description format (as noted in Table 1 for methods and Table 2 for metrics). A conforming description may contain descriptions of processes or approaches in addition to what is included in this part of ISO/IEC 19796. In other words, it is intended to be extensible and may contain additional data elements. If it exists in the reference methods or metrics collection then a reference should be provided to facilitate verification that it is conformant.

3 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC TR 9126-2:2003, *Software engineering — Product quality — Part 2: External metrics*

ISO/IEC 19796-1:2005, *Information technology — Learning, education and training — Quality management, assurance and metrics — Part 1: General approach*

4 Terms and definitions

For the purposes of this document, the terms and definition given in ISO/IEC 19796-1:2005 and the following terms and definitions apply.

4.1
attribute
characteristic of an object or entity

[ISO/IEC 11179-3:2003, 3.1.3]

NOTE 1 An object or entity can have many attributes, only some of which may be of interest for measurement (and attribute can be distinguished object or entity quantitatively or qualitatively by human or automated means).

NOTE 2 Attribute is a measurable physical and abstract property of an entity. [ISO/IEC 14598-1:1999, 4.2]

4.2
measurement
set of operations to determine a value of a measure

NOTE 1 Measurement is a key activity in quality management and assurance. Especially, quality audit and assessment need measurement. Measurement implies a measurement procedure, based on a theoretical model. In practice, measurement presupposes a calibrated measuring system, which should be subsequently verified.

NOTE 2 Measurement is set of operations having the object of determining a value of a measure. [ISO/IEC 15939:2002, 3.17]

NOTE 3 Measurement is a process of experimentally obtaining information about the magnitude of a quantity. [ISO VIM: 2004, 2.1]

4.3
method
〈quality approaches〉
one or a set of instrument(s) or tool(s) to assure and/or to manage quality in processes

NOTE 1 Methods include physical methods and abstract or conceptual methods. There are various types of methods from the subjects of management science, pedagogy, psychology, engineering, statistics, biology etc.

NOTE 2 "Measurement method" is a generic description of a logical sequence of operations used in a measurement. [ISO VIM: 2004]

4.4
metric
〈quality approaches〉
material measure within some aspects of quality characteristics

NOTE 1 In other words, to determine a value, methods of measuring or testing are used in order to quantify a quality object from the standpoint of quality characteristics, such as scale, criterion, degree, weight, magnitude, interval, ratio, or standard rate.

NOTE 2 “Material measure” is defined as a device reproducing or supplying, in a permanent manner during its use, quantities of given kinds, each with an assigned value. [ISO VIM: 2004]

NOTE 3 In ISO/IEC 15939:2002, the metric is defined as "the defined measurement methods and the measurement scale". However metrics need to be clearly divided between the terms of method and scale because of implementation for audit and assessing.

4.5
scale
ordered set of values, continuous or discrete, or a set of categories to which the attribute is mapped

[ISO/IEC 15939:2002, 3.33]

NOTE 1 The type of scale depends on the nature of the relationship between values on the scale. Four types of scales are

— Nominal: the measurement values are categorical. For example, the classification of defects by their type.

— Ordinal: the measurement values are rankings. For example, the assignment of defects to a severity level.

— Interval: the measurement values have equal distances corresponding to equal quantities of the attribute.

— Ratio: the measurement values have equal distances corresponding to equal quantities of the attribute where the value of zero corresponds to none of the attribute. For example, the size of a software component in terms of lines on code (LOC).

The method of measurement usually affects the type of scale that can be used reliably with a given attribute. For example, subjective methods of measurement usually only support ordinal or nominal scales.

NOTE 2 Measurement scale is defined as "ordered set of values of quantities of a given kind, continuous or discrete, used in arranging quantities of the same kind by magnitude". [ISO VIM:2000, 2.8]

4.6
validation
confirmation, through the provision of objective evidence that the requirements for a specific intended use or application have been fulfilled

[ISO 9000:2005, 3.8.5]

NOTE 1 Confirmation by examination and by resulting evidence that particular requirements for a specific intended use are fulfilled. [ISO 8402:1994]

NOTE 2 Confirmation through examination of a given item and provision of objective evidence that it fulfils the requirements for a stated intended use. [ISO VIM: 2004, 2.28]

4.7
verification
confirmation, through the provision of objective evidence, that specified requirements have been fulfilled

[ISO 9000:2005, 3.8.4]

NOTE 1 Confirmation by examination and by resulting evidence that specified requirements have been fulfilled. [ISO 8402:1994]

NOTE 2 Confirmation through examination of a given item and provision of objective evidence that it fulfils specified requirements. [ISO VIM:2004, 2.27]

5 Mapping quality approaches

5.1 Quality approaches and ISO/IEC 19796 series

ISO/IEC 19796-1 focuses on aspects of quality approaches and on a process-oriented framework in order to design, plan, understand, manage, and evaluate quality in an organization and within sectors or markets in which information technology systems are used for learning, education, and/or training. ISO/IEC 19796-3 provides ITLET stakeholders with more detailed reference information regarding methods and metrics that are aligned with ISO/IEC 19796-1, and may be used to help in the design, development, implementation, and evaluation of an ITLET quality management system. Together quality metrics and methods may be used to assure quality for stakeholders and to fulfill an organization's quality objectives.

ISO/IEC 19796 series consists of five parts. The relationship among these five parts is described in Figure 1. ISO/IEC 19796-1 provides perspective focuses on lifecycle processes for quality and it is located at the left of Figure 1.

Organizations and providers that produce, provide, and deliver information technologies for learning, education, and training, use quality approaches in order to provide assurance of quality and to continuously improve the quality of their products and services. The Reference Framework for the Description of Quality Approaches (RFDQ) outlined in ISO/IEC 19796-1 provides a framework that may be used to design and develop a quality management system. The flow of ISO/IEC19796-1 is represented by the "a" line in the figure. Quality information using ISO/IEC 19796-1 that is relevant to all stakeholders in the process is recorded and reported to stakeholders in order to assure and to improve quality (see the diagonally shaded area in the top of the figure).

There are many organizations/providers that use a variety of quality management and assurances approaches that may be sector or industry-based. ISO/IEC 19796-2 is being developed In order to harmonize the various aspects and types of quality approaches, (see line "b").

In cooperation with stakeholders, organizations/providers will identify how quality will be measured, the types of information that will be recorded, the methods that will be used, and how this information will be reported. ISO/IEC 19796-3 may be used by stakeholders, and organizations and providers to describe the methods and metrics that will be used for the quality management system. There are three flows related to ISO/IEC 19796-3, which are indicated by the “c”, "d" and "e" lines. The "c" line means that ISO/IEC 19796-1 notes that more detailed information regarding quality methods and metrics are provided in 19796-3. The "d" line means that the reference models of ISO/IEC 19796-3 can be used for quality management and assurance independently, depending on the needs of stakeholders. The "e" line indicates that a collection of ISO/IEC19796-3 methods and metrics can be searched and used as a reference to support the comparison and selection of quality methods and metrics.

ISO/IEC 19796-4 provides guidelines with good practice implementations of ISO/IEC 19796-1. The flow of ISO/IEC 19796-4 indicating that this part may be used to support the implementation of 19796-1 is described by the “f” line and the diagonally shaded areas “record” and “report to assure and improve quality.

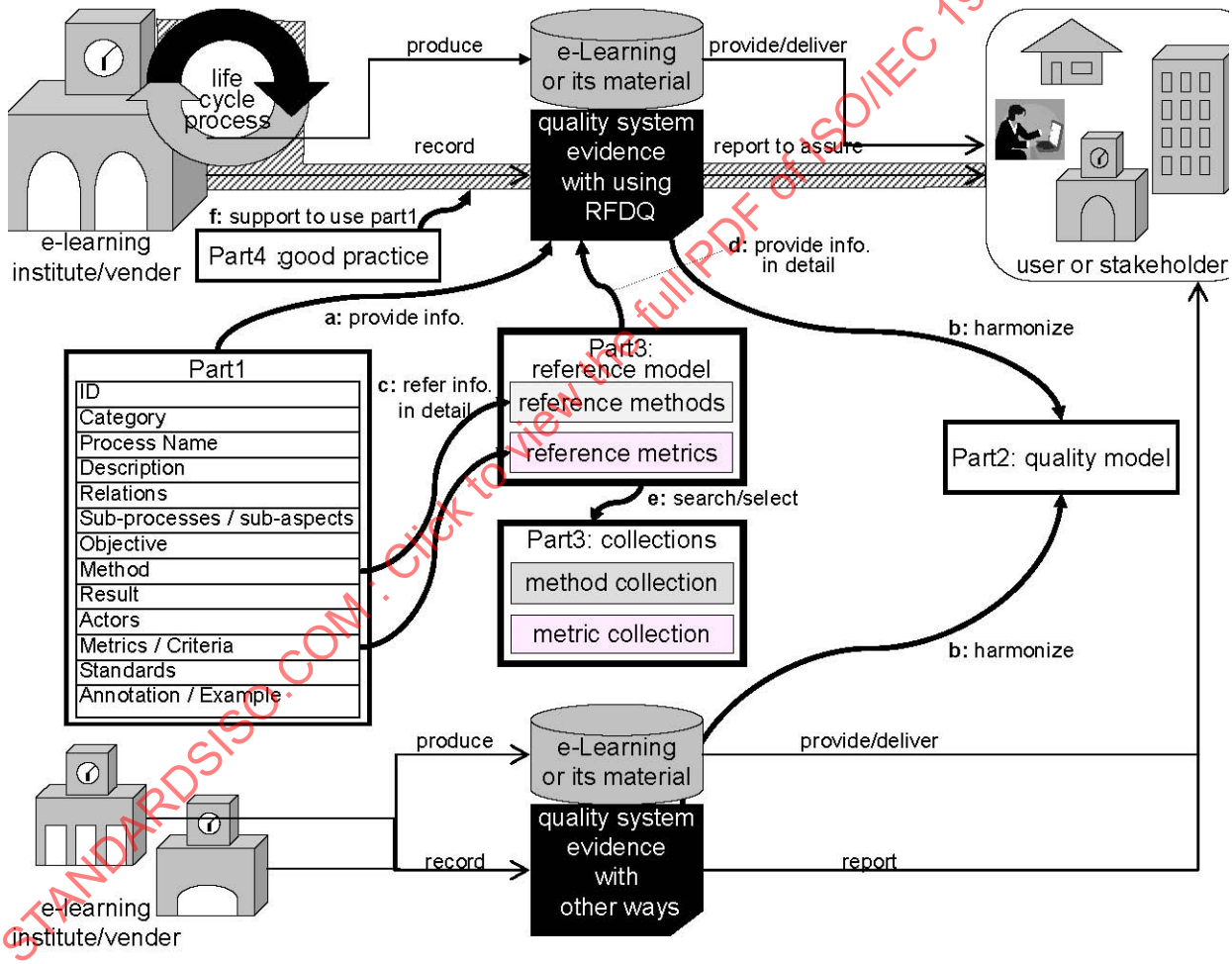

Figure 1 — Mapping quality approaches and ISO/IEC 19796 series

5.2 Practical guideline for quality approaches

In ISO/IEC 19796-1, the process-oriented model is divided into 7 processes. For validation and verification of quality approaches, it is important to identify what aspects should be measured and how value should be assessed. ISO/IEC 19796-1 defines the life cycle processes of quality approaches as non-sequential stages, and defines 13 items of RFDQ's attributes as a reference and descriptive model (see the left side of Figure 1). However, it does not focus on the characteristics of quality approaches.

The main purpose of this ISO/IEC 19796-3 is to facilitate the concrete implementation of quality approaches by providing implementation methods and metrics for measurement. Attributes and data elements are used to facilitate the documentation, analysis and comparison of different quality approaches for the development and use of information technology within learning, education, and training.

In addition to being useful for evaluating, auditing, goal setting and improving quality approaches in e-learning, quality methods and metrics can be used to define quality requirements to a detailed and substantial level. The communication and agreement on quality requirements and approaches beforehand using ISO/IEC 19796-3 could help to evaluate and ensure the effectiveness of information technologies in meeting the teaching and learning needs of ITLET stakeholders.

6 Quality management / assurance activity model

Products and services are defined as a result of one or more process(es). Information technology products and services that are developed and utilized for learning, education, and training are the result of one or more process(es). Data regarding the quality of these processes and their resultant products and services may be recorded and reported to stakeholders to assure and to improve quality. The ISO/IEC 19796 series provides a framework to guide the identification of quality data types, to harmonize different quality management systems, to identify quality metrics and methods, and to provide examples of best practice for quality e-learning.

Quality management and assurance activities should be performed not only for quality management purposes, but as an integrated part of product and service development process and sub-process. Developers select and use methods and metrics during the development processes and sub-processes. While from the viewpoint of quality management and assurance, these activities can be recognized as quality related activities. As an example, the project manager of an e-Learning project should define requirements and evidence criteria for quality of products and services within the project. This will allow organizations/providers to plan, use, evaluate, and improve quality processes and sub-processes to assure stakeholders regarding the quality of their product(s) and/or service(s).

Each stakeholder may have a different perspective for the same activities. For example, a developer might select a specific method or metric for use in his/her developmental activities, whereas a project manager might use the entire reference model to ensure that the project process and/or outcome meet the desired quality.

A variety of specific implementations are already in place in industry, academia, and government. A combination of methods and metrics are purposefully combined to achieve a certain quality objective. Examples are 1) a mobile phone company using metrics for early fault detection for their e-learning software; 2) a public institution using methods to assure and measure customer satisfaction or 3) an academic institution using software quality metrics to evaluate the quality of student portfolio software. These methods and metrics have different functions, such as quality control, quality assurance, or both. For example, the methods “workshop”, "interview", and “fishbone analysis” might be selected for development, and executed and used by developers. While these methods are effective and adequate to identify specific educational requirements and to define concrete educational objectives or outcomes in the needs analysis process and in the framework analysis process (right side of Figure 2), these methods are meaningful to assure their processes and outcomes using its statistical data or diagram. Of course, workshop and interview can be used in the framework analysis, and fishbone analysis can be effective in the needs analysis. Developers will select some methods for each process for their suitability.

Methods and metrics are needed to identify how to utilize quality management and assurance to improve development processes and sub-processes for information technologies for learning, education, and training. The left side of Figure 2 indicates the process that can be used to ensure that quality management and assessment is applied during the development and implementation of information technologies for learning, education, and training.

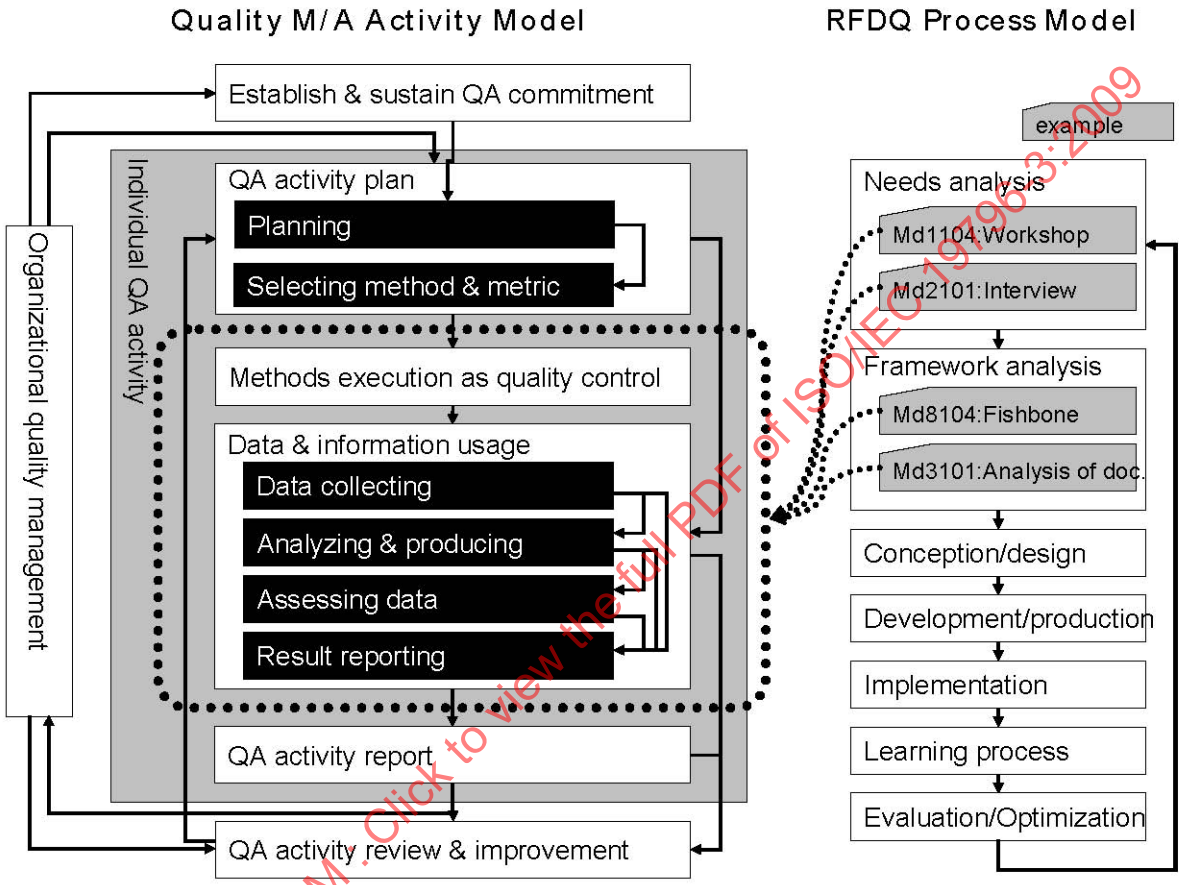

Figure 2 — Quality management/assurance activity model and relationship with RFDQ

7 Reference model for quality methods

The entity "quality approach" is described by its attributes. The entity "quality approach" is combined with "methods". Each method and metric as part of quality approaches should be characterised by certain attributes. An attribute can be defined by information which is merged with category data and element data. This standard provides a reference model identifying attributes for methods and recommends a model with common categories and data elements.

It is a significant issue to develop and to integrate methods or to use existing methods in order to measure the success of the quality assurance and management by adapting ISO/IEC 19796-1. These methods should be comparable, interoperable and exchangeable between systems.

7.1 Categories

Both categories and sub categories are derived in order to identify the method for quality approaches. Using these categories, all stakeholders (developer, provider, teacher, learner, personnel staff, and subject matter experts (SME)) can easily understand quality approaches and decide which information about product and service are reliable or not.

In this standard, there are seventeen categories (ID, name, objective, usage type, description, source, rights, scope/quality characteristics, context, method type, object of quality, process, actor/representative, relation, standard reference, annotation, and experiences) and some sub-categories.

1) ID
   Unique identifier of the method

2) Name
   Name or title of the method for quality management or assurance

3) Objective
   Objective of the method for quality management and assurance. The information is basically targeted just to a method itself, so it is useful to describe and understand the aim/goal of a method in general meaning.

4) Description
   Short description of the method

5) Usage type
   Type of the usage of the method. A method has one or more general purpose, but it is used with a specific purpose in practice.

6) Source
   Origin of the method

7) Rights
   Rights or property connected with the method. If the value is “1 (true)”, sub-categories of “RightID” and “RightDescription” must be defined.

   7-1) RightID
   Unique identifier of the right

   7-2) RightDescription
   Short description of the right

8) Scope / Quality characteristics

Scope indicates which essential quality characteristics are assured or improved by using the method. Quality characteristics is recommended to refer items in “Attribution metrics: Mc3000” listed in the metrics collection. Attribution metrics are focused on characteristic of quality.

9) Context

Context indicates the (pre-)conditions depending on the specific situation for using the method to assure and improve quality.

10) Method type

Characteristic of method processing or operation

10-1) Categories of methods

Classification of methods in the general methodology, which is indicated in the chapter 9.

10-2) Measurement type; measurement method type

Generic description of a logical sequence of operations used in a measurement. Measurement methods may be qualified in various ways such as:

— direct measurement method

— indirect measurement method

— comparison measurement method

— substitution measurement method

— complementary measurement method

— differential measurement method

— null measurement method

— other

NOTE These recommended methods type name value are referred to in IEC 60050-300:2001

10-3) Method resource

Resources and/or services required to perform the method

11) Quality object

The type "quality object" to be managed will depend on the stage in the life cycle process and the purpose of the assurance and management. For example, in an analysis process, a final LMS (Learning Management System) product and/or educational content products may not be quality objects, rather the specification draft or activity of analysis could become the quality objects for some quality process as "process quality". The final LMS product and/or educational content could become quality object as "product quality" or "usability quality" in the evaluation stage.

There are many reasons for quality management and assurance in the analysis stage, someone must assure the efficiency of learning, and the other one must assure the reliability of learning. The former focuses on report or activity of need analysis, the latter will focuses on system of organization.

12) Process

This refers to the life cycle process shown at ISO/IEC 19796-1. This identifies which process categories or sub-processes in which the method is used.

12-1) Process category

Process category in which the method is used. Title of process should be referred from the process categories on ISO/IEC 19796-1

NOTE See ISO/IEC 19796-1 4.2, NA; needs analysis, FA; framework analysis, CD; conception/design, DP; development/production, IM; implementation, LP; learning process, EO; evaluation/optimization.

12-2) Sub-Process

Sub-process in which the method is used. Title of sub-process should be referred from the sub-process on ISO/IEC 19796-1

NOTE ISO/IEC 19796-1 4.2.1.1 for NA, 4.2.1.2 for FA, 4.2.1.3 for CD, 4.2.1.4 for DP, 4.2.1.5 for IM, 4.2.1.6 for LP, 4.2.1.7 for EO.

13) Actor/ responsible
Actors and their representative(s) involved in using the method

14) Relation
Relation with other methods used to measure the same item

15) Standards reference
Reference to standards using the method or supported by the method

16) Annotation
Explanatory remarks

17) Experience
Experience with the method

7.2 Elements

"Elements" of method refine the attributes of methods for each category and sub-category. A set of values of these elements construct the information model for each category and sub-category. It provides a clear definition and interoperability.

For this purpose, two steps are necessary: a description format and a collection of methods to be adapted and implemented within quality approaches in organizations. In this standard, there are six elements: ID code, data type, description, mandatory, cardinality, and example for each of categories and sub-categories.

— ID-code

— data type

— description

— mandatory

— cardinality

— example

The following model provides a description format for methods used within quality approaches

Table 1 — Reference model of methods specification

ID-Code	Category	Sub Category	Data type	Description	Mandatory	Cardinality	Example
D01.00	ID		String	Unique identifier	Required	1	LB0001
D02.00	Name		String	Name or title of the method	Required	1	Learning Benchmarking
D03.00	Objective		String	Objective of the method	Recommend	N	Learning Benchmarking shall provide an indication of human resources development(HRD) strengths and weaknesses
D04.00	Description		String	Short description of the method /instrument	Recommend	N	Learning Benchmarking is used to continuously evaluate and measure the success of training within organizations over a defined period of time
D05.00	Usage type		String	Type of the usage of the method. A method has one or more general purpose, but it is used with specific purpose in practice.	Optional	N	Improvement and motivation for their staff to development activities
D06.00	Source		String	Origin of the method	Optional	N	www.learningmethods.eu
D07.00	Rights	Rights	Boolean	Information on rights for the method. If the value is “true”, RightID and RightDescription should be defined.	Recommend	1	"0 (false)" or "1 (ture)"
D07.01		RightID	String	Unique identifier of the rights	Optional	1	Rigd00101
D07.02		RightDescription	String	Description of legal aspects of the method	Optional	N	“Use of LB must be registered with the LB Institute”
D08.00	Scope / Quality characteristics		String	Scope indicates which essential quality characteristics are assured or improved using the method. It provides a view point or direction to identify the meaning of management and assurance. These information are included the general or environmental information and didactical information.	Optional		“Effectiveness” of learning “Reliability” of LMS “Functionality” of service
D09.00	Context		String	Context for which a method is suitable	Optional		SMEs HR Development

Table 1 (*continued*)

ID-Code	Category	Sub Category	Data type	Description	Mandatory	Cardinality	Example
D10.00	Method type			Characteristic of method processing or operation			
D10.01		Categories of methods	QName	Classification to explain the general methodology as follows *Value space: Collection of reference or {“discussion/talks”, “survey”, “analysis”, “implementation models/guidelines”, “measurement”, “testing”, “modelling”, and other things}	Recommend	1	Testing
D10.02		Measurement type	QName	generic description of a logical sequence of operations used in a measurement	Optional		Indirect measurement method
D10.03		Methods resources	String	Resources and services to perform the methods	Optional	n	Questionnaire XYZ; Reporting tool
D11.00	Quality object		String	Object is a thing or an entity for which the method uses to assure or to manage quality approaches. Object can be described as hierarchical structure using “ / ”. Hierarchical structure can be defined the range or granularity. Top level of object are recommended some types as follows, Value space of top level objects: “Organization”, “Project”, “Process”, “Product”, “Usability”, “Learning”	Recommend	n	Organization/ Policy&Strategy Organization/ Policy&Strategy/ Definition Product/ Affective feedback function Usability/ System install

Table 1 (*continued*)

ID-Code	Category	Sub Category	Data type	Description	Mandatory	Cardinality	Example
D12.00	Process			Phases/stage of life cycle process based on ISO/IEC 19796-1			
D12.01		Process categories	QName	Process name of the life cycle process based on ISO/IEC 19796-1. Value space as follows 1. “NA; needs analysis”, 2.”FA; framework analysis”, 3,“CD; conception/design”, 4,“DP; development/production”, 5,“IM; implementation”, 6,“LP; learning process”, 7, “EO; evaluation/optimization”	Recommend	N	3,CD; conception/design
D12.02		Sub process	QName	Sub process name of the life cycle process based on ISO/IEC19796-1.	Recommend	N	Learning objectives
D13.00	Actor/ repre-sentative		String	Actors and their representative involved using the method	Recommend	N	HR manager, evaluator
D14.00	Relation		String	Relation with other methods to measure same item	Optional	N	Include LM0005
D15.00	Standard reference		String	Normative reference to standards using the method or supported by the method	Optional	N	ISO 9000:2005
D16.00	Annotation		String	Explanatory Remarks	Optional	N	The method should be used only in the telecommunication sector
D17.00	Experience		String	Experiences made with the method	Optional	N	Method was used to measure the ROE (Return On Education; ROI in Education).

8 Reference model for quality metrics

The entity "quality approach" is described by its attributes. The entity "quality approach" is combined with metrics. Each entity "metric" is identified by its attributes. An attribute can be defined by information which is merged with category data and element data. This standard provides a reference model identifying attributes, for metrics and recommends using its model with common categories and data elements.

It is a significant issue to develop and to integrate metrics or to use existing metrics in order to measure the success of the quality assurance and management by adapting ISO/IEC 19796-1. These metrics should be comparable, interoperable and exchangeable between systems.

8.1 Categories

Both categories and sub categories are picked up as attributions of metrics in quality approach. A set of these attributions let a metric property clear in order to identify the metric for quality approaches. Using these categories, all stakeholders, developers, providers, teachers, learners, personnel staff, and SMEs easily understand the quality approaches and can judge which products and services are reliable.

In this draft, there are twelve categories (ID, name, objective, description, source, rights, scope, metrics type, periods, actors, annotation, and experience) and some sub-categories.

1) ID
   Unique identifier of the metric

2) Name
   Name or title of the metric for quality management and assurance

3) Objective
   Objective of the metric for quality management and assurance

4) Description
   Short description of the metric

5) Source
   Origin of the metric

6) Rights
   Rights or property connected with the metric. If the value is “1 (true)”, sub-categories of “RightID” and “RightDescription” must be defined.

   6-1) RightID
   Unique identifier of the right

   6-2) RightDescription
   Short description of the right

7) Scope / Quality characteristics
   Scope indicates which essential quality characteristics are assured or improved by using the metrics. Quality characteristics refer to items in “Attribution metrics: Mc3000” listed in the metrics collection. Attribution metrics are focused on characteristic of quality.

8) Metric type
   Characteristic of metric processing or operation

   8-1) Metric category

Classification of metrics in the general methodology. Some data can be acquired by executing the method as outputs. These data can divide some types of data, and might be used to assure or to manage quality. These data can be called “evidence data” for assuring and managing quality.

Example; "categorizing", "rating", "ranking", "positioning", "mapping", "approve/disapprove", "behaviour description", and "other things".

8-2) Calculation

A way to calculate or to derive information as a metric. The most important thing is which subjective data or objective data is used to calculate the metric. Some types of information are subjective self-assessment or response, subjective peer evaluation, subjective evaluation with concrete evidence, subjective evaluation with 3rd party, statistical data with subjective data, objective data, and/or statistical information with objective data.

8-3) Scale type

Scale of the metric type. Scale type may be qualified in various ways such as:

— nominal
— ordinal
— interval
— ratio
— absolute

NOTE 1 These recommended scale type name value are referred to ISO/IEC 9126-2; 2003

— rate
— other

NOTE 2 Two scale type name value listed above are useful to identify in detail.

8-4) Criterion

To indicate the target level of value. Target value is useful in understanding the meaning of the actual data or output after calculation of method and metric. So criteria include “ideal level”, “average level”, “borderline” and so on.

8-5) Metric resource

Resources and services to perform the metric

9) Period
Period to use the metric

10) Actor/ responsible
Actors and their representatives using the metric.

11) Annotation
Explanatory remarks

12) Experience
Experiences made with the metric

8.2 Elements

"Elements" of metrics refine the attributes of metrics for each category and sub-category. A set of values of these elements construct the information model for each category and sub-category. It provides a clear definition and interoperability.

For this purpose, two steps are necessary: a description format and a collection of metrics (such as indicators) to be adapted and implemented within quality approaches in organizations. In this standard, there are six elements: ID code, data type, description, mandatory, cardinality, and example for each of categories and sub-categories.

— ID-code

— data type

— description

— mandatory

— cardinality

— example

The following model provides a description format for metrics used within quality approaches.

Table 2 — Reference model of metrics specification

Code	Category	Sub Category	Data type	Description	Mandatory	Cardinality	Example
C01.00	ID		String	Unique identifier	required	1	LS0001
C02.00	Name		String	Name of the metric	required	1	Learning Satisfaction
C03.00	Objective		String	Objective of the metric	recommend	N	LS shall show the aggregate learner satisfaction in different phases of a course
C04.00	Source		String	Origin of the metric	optional	N	www.learningmetrics.eu
C05.00	Description		String	Short description of the metrics	Recommend	N	
C06.00	Rights	Rights	boolean	Information on rights for the metric	optional	1	"0 (false)" or "1 (ture)"
C06.01		RightID	String	Unique identifier of the rights	optional	N	Rigc00101
C06.02		RightDescription	String	Description of legal aspects of a metric	optional	N	“Use of LB must be registered with the LB Institute”
C07.00	Scope / Quality characteristics		String	Scope indicates which essential quality characteristics are assured or improved using the metrics. It provides a view point or direction to identify the meaning of management and assurance. This information is included in the general or environmental information and didactical information.	Optional	N	“Effectiveness” of learning “Reliability” of LMS “Functionality” of service
C08.00	Metric type			Characteristic of metric processing or operation			
C08.01		Metric category	String	Some data can be acquired by executing the method as outputs. These data might be used to assure or to manage quality. Because these data can be said “evidence data” for assuring and managing quality. In this item, data type of an evidence data will be indicated.	recommend	1	categorizing, rating, ranking, positioning, mapping, approve/disapprove, behavior description, and other things

Table 2 (*continued*)

Code	Category	Sub Category	Data type	Description	Mandatory	Cardinality	Example
C08.02		Calculation	String	A way to calculate or to derive its information as a metrics. The most important thing is which subjective data or objective data are used on or are indicated as a metric.	optional	N	Subjective judgement LB = Response times/1h
C08.03		Scale type	QName	Scale of the metric type(or reference) Value space: "nominal", "ordinal", "interval", "ratio", "absolute", and "rate" See Terms and definitions, and ISO/IEC9126-2;	required	1	Nominal
C08.04		Criterion	String	Ideal or average level, or comparing with certain object	optional	N	Ideal(recommended level):3.4 Average(fair level):2.5
C08.05		Resources	String	Resources and services to perform the metric	optional	N	Questionnaire XYZ; Reporting tool
C09.00	Period		String	Period to use the metric	optional	1	Once; continuously, n times per course
C10.00	Actor/ responsible		String	Actors and their competencies involved to use the metric	optional	N	HR manager, evaluator
C11.00	Annotation		String	Explanatory Remarks	optional	N	
C12.00	Experience		String	Experiences made with a metric	optional	N	Metric was used to measure the learner satisfaction over three years and gave indicators to improvement potentials. LS=xxx

9 Collection of methods and metrics

9.1 Collection of methods

The following table consists of a classification of categories, category descriptions, and sub-categories of methods.

Table 3 — Collection of methods

ID		Category	Category Description	Sub categories	Method title
Md	1000	Discussion / Talks	Face to face communication oriented by quality (management)		
Md	1100			Discussion / Talks	
Md	1101				Expert talk
Md	1102				Group discussion
Md	1103				Feedback talk
Md	1104				Workshop
Md	1105				Round table
Md	2000	Survey	Questions concerning a specific quality topic		
Md	2100			Survey	
Md	2101				Interview
Md	2102				Audit
Md	2103				Poll
Md	2104				Questionnaire of user response
Md	3000	Analysis	Analysis regarding single aspects		
Md	3100			Analysis	
Md	3101				Analysis of documents
Md	3102				Analysis of interviews
Md	3103				Market data exploration
Md	3104				Needs analysis
Md	3105				Market research and analysis
Md	3106				Analysis of organisations
Md	3107				Trend analysis
Md	3108				Analysis of processes
Md	3109				Analysis of target groups
Md	3110				Impact analysis
Md	3111				Arbeitsplatzanalyse
Md	3112				Working place analysis
Md	3113				Analysis of literature
Md	3114				FRAP (Frequencies Relevance Analysis of Problems)

Table 3 (*continued*)

ID		Category	Category Description	Sub categories	Method title
Md	3115				Methods of trend research
Md	3116				Skill gap analysis
Md	3117				Plan-actual-comparison
Md	3118				´´+ / -´´ analysis
Md	3119				Statistical testing
Md	3120				Correlation analysis
Md	3121				Variance analysis
Md	3122				Regression analysis
Md	3123				IRT(Item response testing)
Md	3124				Path analysis
Md	3125				Factor analysis
Md	3126				Cluster analysis
Md	3127				S-P analysis
Md	4000	Implementation models and guidelines	Models and guidelines for quality management and quality assurance		
Md	4100			Implementation models and guidelines	
Md	4101				Measurement models and schemes
Md	4102				Balanced scorecard (BSC)
Md	4103				Generic realization of learning processes by Baumgartner
Md	4104				SDM: Software Development Model
Md	4105				CIPP model (Context, Input, Process, Product)
Md	4106				PEI model (Pedagogical Effectiveness Index)
Md	4107				SPE model (Standardized Parameter Estimates)
Md	4108				Instructional design for multi media
Md	4109				UCIT (Universal Constructive Instructional Theory)
Md	4110				Step by step model of technology integration into teaching
Md	4111				O-P-T model (Optimum, Performance, Training)
Md	4112				3 level model (evaluation)
Md	4113				EFQM Excellence Model: different methods has to be listed separately

Table 3 (*continued*)

ID		Category	Category Description	Sub categories	Method title
Md	5000	Measurement	Evaluation of suitability, appropriateness, and efficiency to reach the objectives		
Md	5100			Measurement	
Md	5101				Benchmarking
Md	5102				Inspection
Md	5103				Certification
Md	5104				Accreditation
Md	5105				Quality cycle
Md	5106				Statistical validation
Md	5107				Recension
Md	5108				Comparison group
Md	5109				Expert review
Md	5110				Evaluation
Md	6000	Testing	Procedure to measure and verify one or more items		
Md	6100				
Md	6101				Design test of modules
Md	6102				Testing of functionalities
Md	6103				Endurance testing
Md	6104				Integration test
Md	6105				Usability test
Md	7000	Modeling	Building of an abstract model according to the reality		
Md	7100			Modeling	
Md	7101				Role model
Md	7102				Workflow modeling
Md	7103				Process modeling
Md	7104				Organisational models
Md	7105				EPC (Event-driven Process Chain)
Md	7106				SEM (Structural Equity Modeling)
Md	8000	Quality control and quality engineering method	Finding quality problem, and control and improve quality		
Md	8100			Quality control and quality engineering method	
Md	8101				Pareto chart
Md	8102				Histogram

Table 3 (*continued*)

ID		Category	Category Description	Sub categories	Method title
Md	8103				Control chart
Md	8104				Cause-Effect diagram: Fishbone analysis
Md	8105				Check sheet: Check-list
Md	8106				Scattered diagram
Md	8107				Stratification
Md	8108				Affinity diagram
Md	8109				Association diagram
Md	8110				Tree diagram
Md	8111				Metrics diagram
Md	8112				PERT method (Program Evaluation and Review Technique)
Md	8113				PDPC(Process Decision Program Chart)
Md	8114				Gantt chart
Md	8115				Time study
Md	8116				Motion study
Md	8117				Value engineering
Md	8118				Taguchi method
Md	8119				Zero defect
Md	9000	Problem solving method	To promote and to make effective their ways of thinking for problem solving		
Md	9100			Problem solving method	
Md	9101				Brain storming
Md	9102				Card writing
Md	9103				Brain writing
Md	9104				Input-Output technique
Md	9105				Synthetics method
Md	9106				Delphi method
Md	9107				NM method（Nakayama Masakazu）
Md	9108				KJ method (Nominal group technique)
Md	9109				Cross technique (7 cross 7)

9.2 Collection of metrics

The following table consists of a classification of categories, category descriptions, and sub-categories of metrics.

Table 4 — Collection of metrics

ID		Categories of metrics	Description	Sub categories	Metrics title
Mc	1000	Function metrics	Focused on functions that were designed and developed to improve learning and related things		
Mc	1100			Learning promotion functions	
Mc	1101				Fundamental navigation
Mc	1102				Formative evaluation feedback
Mc	1103				Compatible sequencing
Mc	1104				Personalized learning
Mc	1105				Promoting understanding
Mc	1106				Promoting stability
Mc	1107				Promoting transfer/application
Mc	1108				Awareness of the state of understanding (meta acknowledgement)
Mc	1200			Learning support function	
Mc	1201				Study guidance
Mc	1202				Automatic e-Learning content summarizing system and query function for troubles
Mc	1203				Response (mentoring) function for content queries
Mc	1204				My - page registration
Mc	1205				Mentoring
Mc	1206				Tutoring
Mc	1207				Community development
Mc	1208				Book - mark
Mc	1209				Reference link
Mc	1210				Subject search link
Mc	1300			Learning sustainability function	
Mc	1301				Ratio of audio used to overall content amount
Mc	1302				Learning enhancement/display of progress information

Table 4 (*continued*)

ID		Categories of metrics	Description	Sub categories	Metrics title
Mc	1303				Learning enhancement/notification of progress information
Mc	1304				Informational feedback on learning activities
Mc	1305				Emotional/affective feedback (encouragement) on learning
Mc	1306				Informational feedback on tests
Mc	1307				Emotional/affective feedback (encouragement) on tests
Mc	1308				Amount of Face-to-Face Communication with Instructors/Education Institutions
Mc	1309				Pre-test of knowledge and skills
Mc	1310				Post-test of knowledge and skills
Mc	1311				Self configuring function of learning Type/Learning Period
Mc	1312				Ratio of audio used to overall content amount
Mc	1400			Educators support function	
Mc	1401				Feedback information of learners to improve instruction method and activities
Mc	1402				Feedback information from learners to appropriately redesign instruction designs
Mc	1403				Authoring deport for creation of learning materials
Mc	1404				Function to allow reuse of e-Learning contents
Mc	1405				Function for managing e-Learning contents
Mc	1500			Usage function	
Mc	1501				Display of fundamental navigation device
Mc	1502				Screen display
Mc	1503				Consistency of screen appearance and operation icons
Mc	1504				Starting operation of learning
Mc	1505				Operationability of each optional function
Mc	2000	Element metrics	Identifying quality concept and status with indicating components, educational related objects, or activities.		

Table 4 (*continued*)

ID		Categories of metrics	Description	Sub categories	Metrics title
Mc	2100			Learning evaluation	
Mc	2101				Diagnostic evaluation
Mc	2102				Formative evaluation
Mc	2103				Summative evaluation
Mc	2104				Relative evaluation; comparing with others
Mc	2105				Contents standard evaluation(domain referenced)
Mc	2106				Performance standard evaluation (performance referenced)
Mc	2107				Rubric evaluation
Mc	2108				Achievement evaluation
Mc	2109				Internal referenced evaluation
Mc	2200			Course evaluation	
Mc	2201				Educational objectives
Mc	2202				Educational contents
Mc	2203				Educational materials
Mc	2204				Instruction plan
Mc	2205				Instruction style
Mc	2206				Instruction process
Mc	2207				Instruction sequence
Mc	2300			Curriculum evaluation	
Mc	2301				Curriculum policy
Mc	2302				Curriculum-courses composition
Mc	2303				Course-units composition
Mc	2304				Composition principal
Mc	2305				Curriculum conditions
Mc	2306				Facility for curriculum
Mc	2307				Staff for curriculum administration
Mc	2308				Learners characteristics and social environment
Mc	2400			Instructor evaluation	
Mc	2401				Instruction performance
Mc	2402				Instruction technique
Mc	2403				Instruction methods
Mc	2404				Instruction style
Mc	2405				Effort for instruction

Table 4 (*continued*)

ID		Categories of metrics	Description	Sub categories	Metrics title
Mc	2406				Skill for material and tool development
Mc	2407				Adequate feedback
Mc	2500			Institution/school evaluation	
Mc	2501				Institution policy
Mc	2502				Institution strategy
Mc	2503				Activity of administration
Mc	2504				Whole responsibility for quality
Mc	2505				Performance of administration
Mc	2506				Quality adjectives
Mc	2507				Staff training and development
Mc	2508				Human communication management in institution
Mc	2509				Relationship to social and regional
Mc	3000	Attribution metrics	Identifying quality concept and status with indicating essential characteristics		
Mc	3100			Functionality	
Mc	3101				Suitability
Mc	3102				Accuracy
Mc	3103				Interoperability
Mc	3104				Compliance
Mc	3105				Security
Mc	3200			Reliability	
Mc	3201				Maturity
Mc	3202				Fault tolerance
Mc	3203				Recoverability
Mc	3300			Usability	
Mc	3301				Understandability
Mc	3302				Learnability
Mc	3303				Recoverability
Mc	3400			Efficiency	
Mc	3401				Time behaviour
Mc	3402				Resource behaviour
Mc	3500			Maintainability	
Mc	3501				Analyzability
Mc	3502				Changeability

Table 4 (*continued*)

ID		Categories of metrics	Description	Sub categories	Metrics title
Mc	3503				Stability
Mc	3504				Testability
Mc	3600			Portability	
Mc	3601				Adaptability
Mc	3602.				Installability
Mc	3603				Conformance
Mc	3604				Replaceability
Mc	3700			Educational suitability	
Mc	3701				Appropriateness
Mc	3702				Clarity
Mc	3703				Convenience
Mc	3704				Variety
Mc	3705				Initiative
Mc	3706				Specialty
Mc	3707				Up-to-date
Mc	4000	Scale metrics	Characteristics of measured quality data		
Mc	4100			Time	
Mc	4101				Limited time
Mc	4102				Deal line; delivery
Mc	4103				Shortest possible time
Mc	4104				Longest possible time
Mc	4200			Period	
Mc	4201				Learning period
Mc	4202				Development period
Mc	4203				Revision period
Mc	4204				Period for understanding
Mc	4205				Period for mastering
Mc	4300			Response	
Mc	4301				System response time
Mc	4302				Communication time
Mc	4303				Response time for question
Mc	4304				Learner response time
Mc	4305				Start-up time
Mc	4306				Response time for testing
Mc	4307				Response time of learning result feedback

Table 4 (*continued*)

ID		Categories of metrics	Description	Sub categories	Metrics title
Mc	4400			Amount	
Mc	4401				The entire amount
Mc	4402				Sum total for understanding
Mc	4403				Sum total for mastering
Mc	4404				Sum total for satisfaction
Mc	4405				Total cost
Mc	4406				Total code
Mc	4407				Total function points
Mc	4408				Total functions
Mc	4409				Total files
Mc	4410				Total number of revisions
Mc	4411				Total performance
Mc	4500			Statistical basis	
Mc	4501				Average (arithmetic mean)
Mc	4502				Mode
Mc	4503				Median
Mc	4504				Maximum
Mc	4505				Minimum
Mc	4506				Variance
Mc	4507				Standard deviation
Mc	4600			Rate	
Mc	4601				Amount/time
Mc	4602				Amount/cost
Mc	4603				Rate of learning/cost
Mc	4604				Rate of teaching or instruction/cost
Mc	4605				Rate of development/cost
Mc	4606				Rate of learning/time
Mc	4607				Rate of teaching or instruction/time
Mc	4608				Rate of development/time
Mc	4609				Increasing rate
Mc	4610				Decreasing rate
Mc	4611				Average of capacity
Mc	4612				ROI; return on investment
Mc	4613				BCR; benefit cost ratio
Mc	4614				MTBF; mean time between failures

Table 4 (*continued*)

ID		Categories of metrics	Description	Sub categories	Metrics title
Mc	4615				MTTR; mean time to repair
Mc	4616				Turnover rate
Mc	4617				Improvement rate
Mc	4700			Frequency	
Mc	4701				Frequency of error
Mc	4702				Frequency of behaviour
Mc	4703				Frequency of appearance
Mc	4704				Frequency of usage
Mc	4800			Degree	
Mc	4801				Threshold
Mc	4802				Likert scale
Mc	4803				Semantic differential
Mc	4804				Percentage
Mc	4805				Co-relation

Annex A
(informative)

Description format examples of methods reference model

A.1 Introduction

This annex provides two examples of method formats from different methods collections using the methods reference model. The examples have been adapted from quality approaches from AEN (Japan) and KERIS (South Korea).

A.2 Example from AEN Japan

The Ministry of Economy, Trade and Industry in Japan (METI) established AEN (Asian E-learning Network). The quality management/assurance working group, AEN-QA, is one of several different AEN working groups. AEN-QA published the AEN quality management/assurance guideline as an assessment check list, and developed a check tool system that is available for use via the Internet. This guideline has over 100 items, and each item has a defined scale. This guideline was used to assess and to assure e-Learning courses for vocational students. It was developed in the National e-Learning project by METI. One of the items and corresponding criteria are provided below as an example.

Table A.1 — Sample method 1

1st. category	2nd. category	3rd. category	Item	Criterion/scale
Process	Analysis	Needs analysis	to indicate and assure needs analysis activities and ways to understand learner and learner's requirements to identify the learning objectives	5 point scale that includes key behavioral evidence