Comparing eQETIC Model and ISO/IEC 19796-1: Focus on Their Defined Processes

Rogério Rossi[1*], Pollyana Notargiacomo Mustaro[2]
[1] University of São Paulo (USP), São Paulo, Brazil.
[2] Mackenzie Presbyterian University, São Paulo, Brazil.

* Corresponding author. email: rossirogerio@hotmail.com
Manuscript submitted November 21, 2014; accepted December 28, 2014.

Abstract: Needs related to the quality of digital educational solutions are treated by governments, associations, researchers and the society in general, since these solutions are mainly used by students, teachers and tutors. However, many frameworks are identified to support the quality of this type of solutions in an approach that turns to quality assurance or quality control. This research thus presents a comparative analysis guided by two process models that promote quality construction for digital educational solutions pointing out relevant aspects related to these models and their critical points.

Key words: Digital educational solutions, distance education, e-learning, quality in digital education, eQETIC Model, ISO/IEC 19796-1.

1. Introduction

Investigations and researches regarding the quality of digital educational solutions is an urgent condition, especially considering that there are higher demands from contemporary society related to high level quality for several products and services.

Quality itself is a complex characteristic to be verified, and is sometimes observed in a subjective way. For measuring it, quality should be supported by formal methods and standards, as observed by Walter Shewhart during the initial movement of quality in the 1920s.

A systematic review [1] indicates that from 58 articles related to frameworks for digital educational solutions, only five present mechanisms are geared towards quality evaluation of these kinds of solutions, which emphasizes researches and investigations geared towards this theme.

It is thus possible to observe that governments, universities and other private institutions are defining specific frameworks that are related to the quality of educational solutions based on ICT (Information and Communication Technologies), as can be seen in the relevant researches presented by [2] and [3].

There are also specialized frameworks based on the continuous process improvement approach that turn to these type of solutions, such as the 'e-Learning P3 Model' [4] and the 'e-Learning Maturity Model' [5]. Both of them consider principles of continuous process improvement, as presented by SPICE (Software Process Improvement and Capability dEterminnation) project or other similar models.

Another framework based on the continuous process improvement approach focused on digital educational solutions is the eQETIC Model, a Quality Model for Educational Products based on Information and Communication Technologies [6]. This model features specific practices for implementing processes to support the planning, development and maintenance of digital educational solutions according to its three

improvement levels and its six common entities.

Also, proposals related to the process management approach, ISO (International Standardization Organization) creates a standard called ISO/IEC 19796-1 dealing with Information Technology for Learning, Education and Training, also based on an approach dedicated to the management process to develop digital educational solutions.

Since the frameworks based on the process management approach for digital educational solutions has been presented, this research seeks to analyze the processes presented by two of them, the eQETIC Model and the Reference Model presented in the ISO/IEC 19796-1 standard, reviewing the processes and practices established by both frameworks.

To reach its objectives, this research article is organized as follows: section two presents a literature review on the main concepts related to quality, emphasizing in more detail some related works in the literature and which are consistent with the frameworks used for carrying out this research; section three presents the main features of the ISO/IEC 19796-1 standard; section four details the eQETIC Model; section five presents the correlations between both models, i.e., the eQETIC Model and the Reference Model defined by ISO/IEC 19796-1 standard; and, finally, section six presents conclusion and possible future works related to this research field.

2. Literature Review

2.1. Quality and Education

It is relevant to highlight general concepts concerning quality and, specifically, those regarding educational solutions based on digital technologies. In a general context, [7] states that quality is the degree to which an object, such as a process, product or service, meets a set of attributes or requirements; [8] believes that quality is related to compliance with the specified requirements.

Reference [9] presents a concept for the quality that it represents "the degree to which a system, component or process meets: (1) the specified requirements, and (2) the needs and expectations of customers."

For [10], and according to standard ISO 8402, quality is the totality of features and characteristics of a product, process or service that bear its ability to satisfy explicit or implicit needs.

When the concept is considered in the educational area, and more specifically for digital educational solutions, [11] considers quality based on the ISO 9000:2000 standard, in which quality refers to the ability of a set of inherent characteristics of a product, system or process to meet the requirements of customers and other stakeholders.

The concepts regarding quality can sometimes be complementary, but there is no specific and unique definition for the term. Based on studies by the software industry, the quality of a software product is related to the processes used in its development phases [8]. It is hence possible to observe specific frameworks applied to quality management of digital educational solutions that are also based on this approach, considering the relationship between quality and processes.

Reference [12], features quality from the consideration of four eras: 1) inspection; 2) quality control; 3) quality assurance; and 4) strategic quality management. For each of these eras, [12] relates a specific orientation, with the following associations: in the inspection era, quality undergoes inspections after a product is developed; quality control takes place after a product development or at the end of the development cycle; in the quality assurance era, quality is built during a product development; and in the era of strategic quality management, a planned and intensive management of a quality program are employed.

Specifically for e-learning, [3] proposes a systematic approach concerning quality. This approach is,

according to [3], represented by various associations, issuers of by specific frameworks that are defined for evaluating the quality from different aspects. This approach focuses on:

- Quality Management, in which actions aim at the implementation of specific processes and measuring mechanisms for ensuring quality; there are frameworks considered from organizations such as EFQM (European Foundation for Quality Management) and ISO (International Standardization Organization); and specific to the quality of digital educational solutions such as EFQM Excellence Model frameworks;
- Quality best practices, guides and benchmarking, is an approach that considers practices that should be used in order to portray the quality, and it appears in frameworks such as the French Code of Practice in e-Learning presented by AFNOR (*Association Française de Normalisation*), or to other frameworks that are issued by NADE (Norwegian Association for Distance and Flexible Education);
- Systems of Certification and Accreditation, which are related to the certification activities of digital educational solutions, examples of which may be the Distance Education and Training Council of the United States of America and the British Quality Assurance Agency for Higher Education (QAA) in the UK ; and
- Quality competition and Awards, this approach is intended to stimulate top achievements rather than evaluate products or services against a minimum set of objective criteria.

This systematic approach presented by [3] is able to clarify that quality can be observed under different aspects. When the objective is to address quality from a technical viewpoint, adding value to a product, a service, or both; this differs from actions that deal with certification, accreditation, or awards.

2.2. Frameworks Aimed at Quality in Education

Table 1. Examples of Frameworks Aimed at the Quality of Digital Educational Solutions

Framework	Issuer	Year of issue
EADL Quality Guide	EADL - European Association for Distance Learning	2003
NADE'S Quality Standards for Distance Education	NADE - Norwegian Association for Distance Education	2001
French Code of practice – e-learning guidelines	AFNOR - Association Française de Normalisation	2004
Guidelines on the Quality Assurance of Distance Learning	QAA - Quality Assurance Agency for Higher Education	1999
Standards in Open and Distance Learning	British ODLQC Open and Distance Learning Quality Council	2000
ISO/IEC 19796-1 Standard on Quality for e-learning	ISO - International Organization for Standardization	2005
IHEP's Quality on the line	IHEP - Institute for Higher Education Policy (EUA)	2000
Sloan consortium's five pillars of quality	Sloan Consortium	2002
MEC/SEED Benchmarks for Quality of Distance Higher Education	Brazilian Ministry of Education and Culture/Department of Distance Education	2007

Many types of governmental or nongovernmental associations, specific government departments, and

universities, through specialized institutes or researcher groups have proposed and developed mechanisms to verify the quality of digital educational solutions. Hereinafter called frameworks, these documented structures with specific purposes can support quality planning and quality management, at a self-assessment stage or at the certification stage of such solutions.

Therefore, it is possible to observe a set of frameworks, expressed in different structures, with different objectives and methods, as exemplified in Table 1.

From the set of frameworks presented (Table 1), one observes that there is an effort on the part of many international agents in the education area, who consider educational solutions based on ICT (Information and Communication Technologies), in creating a unified framework with normalizing capacity, to promote the quality actions aimed at these solutions [3].

Although it was presented as a set of frameworks in this subsection, there are others that have specific characteristics; their structures are based on the continuous process improvement approach. This kind of frameworks will be presented in greater detail in the following subsection.

2.3. Models Aimed at Continuous Process Improvement Applied to Digital Educational Solutions

The software industry has presented models and standards regarding the quality of a software product and its components. In this sense, it has provided maturity models based on the principle of continuous process improvement, since it considers the process influence throughout the development lifecycle as a relevant element to product quality.

It is possible to observe examples as CMMi (Capability Integration MaturityModel) [13] and the Reference Model (MR-MPS) associated with the Brazilian Program for Software Process Improvement called MPSBR [14], which are capable of supporting the software industry regarding the quality of software products guided by structured development processes.

Reference [15] proposes the use of the concept of maturity models aimed at continuous process improvement for evaluating the quality of digital educational solutions, favoring the development of this type of digital products for education.

The eQETIC Model (Quality Model for Educational Products based on Information and Communication Technologies) [6] has been defined and structured according to this approach that is related to continuous process improvement, as others models such as the 'e-Learning Maturity Model 'presented by [16] and the ' e-Learning P3 model ' defined by [4].

The 'e-Learning Maturity Model' [16] is a maturity model for e-learning products, considering five maturity levels as verified in the extinct SW-CMM (Software Capability Maturity Model). Its maturity levels are: 1) Initiation; 2) Planned; 3) Defined; 4) Managed; and 5) Optimizing.

Another maturity model for digital educational solutions is 'e-Learning P3 Model' presented by [4], grounded in people, process and product, being structured in seven stages: 1) Planning; 2) Design); 3) Production; 4) Assessment; 5) Delivery and Maintenance; 6) Instruction; and 7) Marketing.

Besides these, there is also a model [5], based on principles defined by the SPICE (Software Process Improvement and Capability dEterminnation) Project, which is a process model for e-learning development in which the authors consider five control criteria: 1) Learning; 2) Development; 3) Coordination and Support; 4) Evaluation and 5) Organization.

These examples of frameworks which use the continuous process improvement approach, allows them to be applied in the planning, development and maintenance phases of digital educational solutions. Such proposals may favor the qualitative results of this kind of solutions as e-learning or other solutions that support education according to digital technologies.

3. Relevant Aspects of ISO/IEC 19796-1

The establishment of the ISO/IEC 19796-1 standard was developed under the supervision of Subcommittee 36 - Information and Technology for Learning, Education and Training, associated with the technical committee JTC1 (Joint Technical Committee 1) of IEC (International Electrotechnical Commission) [17]. The standard entitled "ISO/IEC 19796-1: How to Use the New Quality Standard for Learning, Education and Training" provides a guide for using standards for learning, education and training; it was published in October 2005.

The ISO/IEC 19796-1 standard was created as a framework to approximate a variety of quality approaches in the context of learning, education and training [17].

The standard belongs to a set of parts, such as: the ISO/IEC 19796-1 "Part 1: How to use the new Quality Standard for Learning, Education and Training"; the ISO/IEC 19796-2 "Part 2: 'Quality Model'" standards should harmonize the aspects related to the quality system; ISO/IEC 19796-3 "Part 3: 'Reference Methods and Metrics'" that addresses reference methods and measurements; and ISO/IEC 19796-4 "Part 4: 'Best practice and implementation guide'" which presents a set of best practices and implementation guide [3].

Table 2. Reference Model of ISO/IEC 19796-1: 2005

ID	Category	Description/ Sub-Processes
NA	**Needs Analysis**	NA.1 Initiation NA.2 Stakeholder Identification NA.3 Definition of objectives NA.4 Demand analysis
FA	**Framework Analysis**	FA.1 Analysis of the external context FA.2 Analysis of staff resources FA.3 Analysis of target groups FA.4 Analysis of the institutional and organizational context FA.5 Time and budget planning FA.6 Environment analysis
CD	**Conception / Design**	CD.1 Learning objectives CD.2 Concept for contents CD.3 Didactical concept / methods CD.4 Roles and activities CD.5 Organizational concept CD.6 Technical concept CD.7 Concept for media and interaction design CD.8 Media concept CD.9 Communication concept CD.10 Concept for tests and evaluation CD.11 Concept for maintenance
DP	**Development / Production**	DP.1 Content realization DP.2 Design realization DP.3 Media realization DP.4 Technical realization DP.5 Maintenance
IM	**Implementation**	IM.1 Testing of learning resources IM.2 Adaptation of learning resources IM.3 Activation of learning resources IM.4 Organization of use IM.5 Technical infrastructure
LP	**Learning Process**	LP.1 Administration LP.2 Activities LP.3 Review of competency levels
EO	**Evaluation / Optimization**	EO.1 Planning EO.2 Realization EO.3 Analysis EO.4 Optimization / Improvement

However this research will address only the standards specified in Part 1, i.e., in ISO/IEC 19796-1:2005 standard, hereinafter referred as ISO/IEC 19796-1.

With this unique characteristic of being a guide that accommodates the different approaches to quality in this domain, the standard does not correspond to a standard for certification. It is considered a common language concerning quality and a tool for implementing, developing and improving quality in the education area. Thus, it can be used and applied by institutions that deal with the development, acquisition and use of digital educational solutions to deliver services aimed at learning, education and training.

According to [11], quality standards have different characteristics, and to answer the questions regarding quality, one should look at the context and scope, objectives, focus, perspectives, methodology and metrics to be applied. Organizations belonging to different markets, cultures and social contexts should pay attention to the concept of quality as mentioned above to meet their quality requirements aimed to develop and to offer products.

The ISO/IEC 19796-1 standard is structured on a Reference Model of processes that broadly considers the development lifecycle of educational solutions [18]. It can be used for developing different types of digital educational solutions, considering its seven categories of processes and 38 subprocesses, as shown in Table 2.

4. The eQETIC Model

The eQETIC (Quality Model for Educational Products based on Information and Communication Technologies) arose from investigations [6], [19] on the topic of quality for digital educational solutions emphasizing the analysis of issues focused on learning cognitive processes.

The model structure is guided in a continuous process improvement approach, which occurs at their maturity levels to implement the rules that must offer structured processes for the lifecycle of educational solutions based on ICT.

Based on specific theoretical references on the issue of quality for digital education, the model was defined based on concepts and practices that occur in an extensive theoretical set of references from which it is possible to highlight: [3], [8], [11], [20]-[39]. The model' rules support process implementation for planning, development and maintenance of digital educational solutions and they are distributed in six Common Entities: 1) Didactic-Pedagogical, 2) Technology, 3) Management, 4) Support, 5) Tutorial, and 6) Evaluation.

Under this model, digital educational solutions are restricted to e-learning, distance education and learning objects. As specific solutions, such as e-learning and distance education, have different characteristics, confirmed by [21] and [22], they have differentiated treatment by the eQETIC Model. Learning objects are covered broadly by the model considering all the possible objects for this category since the model values the implementation of processes that allow combinations with other specific standards, such as might be used for some specific classes of learning objects.

The model structure can be seen in Fig. 1 and the model components are detailed below.

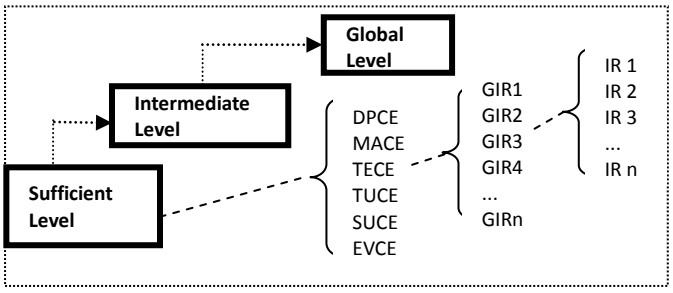

Fig. 1. eQETIC model structure.

The Improvement levels defined for the model allow the organization to enhance its institutional processes already implemented, while new processes are incorporated, favoring maturity and the subsequent optimization of its processes. The three levels defined by the model are: 1) Sufficient Level, 2) Intermediate Level and 3) Global Level.

The way of implementing the processes may vary, but for the organization to achieve the best results, it is considered feasible that the implementation occurs level by level, not implementing two levels at the same moment. Thus, the implementation process should occur primarily at Sufficient Level. After the sedimentation of institutionalized processes, the organization can use the model to implement a new set of processes proposed by the next improvement level, which greatly favors the sedimentation of implemented processes. This gradual implementation of processes allows better results in the measurement process that favors quality management.

The three Improvement Levels consider six Common Entities defined by the model: 1) Didactic-Pedagogical Common Entity, 2) Management Common Entity, 3) Technology Common Entity, 4) Support Common Entity, 5) Tutorial Common Entity and 6) Evaluation Common Entity.

Each Common Entity aims to present a set of Implementation Rules that support the processes that must be institutionalized. The theoretical investigation led to the identification of this set of Common Entities with associated Implementation Rules for each Improvement Level.

The Implementation Rules represent the smallest particle of the model (as shown in Figure 1), and describe what each process must consider before it is ready for use and considered properly institutionalized. The Implementation Rules are unique throughout the model and are not repeated in any eQETIC Improvement Level. All the Implementation Rules are grouped into Groups of Implementation Rules, as these allow the feasibility of implementing the processes, as sometimes an institutional process can meet a group of rules and not just a rule for each group.

The model components aforementioned are presented in Figure 1, as well as other relevant model component is the Educational Product Indicator. This indicator is associated with each Implementation Rule for identifying which digital educational solution a given rule is associated to. As mentioned, the model considers three digital educational solutions: e-learning, distance education and learning objects. In this sense, the indicator contributes to associating the Implementation Rules to the specific solution, as can be seen in Table 3.

Considering its three Improvement Levels and its six Common Entities, the eQETIC Model presents a total of 50 Groups of Implementation Rules for verifying the 89 Implementation Rules of the model in an aggregated manner. Thus, Table 3 illustrates the Implementation Rules of the Technology Common Entity (Sufficient Level). A complete overview of the model, with all the Improvement Levels, Common Entities and Implementation Rules can be verified in [6].

5. Comparative Analysis between the eQETIC Model and ISO/IEC 19796-1

The influences that the process model promotes in an institution may reflect its competitive advantage as well as collaborate with quality results. The quality is highly related to the maturity of the processes that are employed in product development, as can be seen in [40]. To reach its objectives, the education area using ICT depends not only on high quality services, but it also depends on high quality products to support its services.

When an educational institution requires digital solutions in any scenario, as a developer or a purchaser, it needs to establish standards to produce or to acquire them with quality scores that meet their internal and external requirements. If an organization produces these solutions, they should also base their development on rigorous mechanisms and quality standards to offer better results. In both scenarios, quality is a fundamental characteristic increasingly demanded by modern society [3].

Table 3. Implementation Rules of the eQETIC Model - Sufficient Level – Technology Common Entity

Improvement Level: Sufficient			
Common Entity: Technology (TECE)			
Group of Implementation Rules	Educational Product Indicator	Code of Implementation Rule	Description of Implementation Rule
GIRTE 100 – Technology Plan	DE, EL	IRTE 100.1	A Technology Plan must be established and maintained.
	DE, EL	IRTE 100.2	Policies that consider the alignment of the Technology Plan to the Strategic Plan for Online Education should be established and maintained.
GIRTE 101 – Technology Definition	DE, EL	IRTE 101.1	Definition of criteria that justify the acquisition or internal development of all online educational platforms or any of its components, as full courses, learning objects, software, or other specific types of components, must be established and maintained.
	DE, EL	IRTE 101.2	Evidence of use of the criteria that justify the acquisition or internal development of all the online educational platforms or any component that makes up the core of online learning and the results from the use of these criteria should be stored.
GIRTE 102 – Technology Platform	DE, EL	IRTE 102.1	A central technological system must be defined and maintained in order to support the core of online education.
	DE, EL, LO	IRTE 102.2	Specifications and technical data of the central technological system must be documented and updated periodically to support the established activities.
	DE, EL	IRTE 102.3	Regular evaluation of the core online educational system must be guaranteed given any changes made in the central technological system.
GIRTE 103 – Security	DE, EL	IRTE 103.1	Criteria and data security devices for treating all the records (of learners, tutors and others involved, contents, etc.) stored in the central technological system should be established.
GIRTE 104 – Data Base	DE, EL	IRTE 104.1	A database to record all the actions (of management courses, learners and other stakeholders, support, etc.) with the central technological system must be established and maintained.

Therefore, the Reference Model associated with ISO/IEC 19796-1 and the eQETIC Model must meet these requirements in order to structure the process of institutions that adopt them.

This section refers to the processes presented by the ISO/IEC 19796-1 standard and relates them to the eQETIC Model, including detailed sub-processes for analysis. This analysis aims to support those involved in this educational area supported by digital technologies, such as suppliers, producers, purchasers and researchers. They can verify the established processes presented in both models that enable the evolution of digital educational solutions quality, as well as interpret the analysis presented as follows.

The ISO/IEC 19796-1 standard defines seven categories of processes and sub-processes that contribute to the institutionalization of a quality program for digital educational solution development and maintenance. Such processes and sub-processes are used for comparative analysis in which each category highlighted in the ISO/IEC 19796-1 standard is verified in the eQETIC Model.

The seven categories of ISO/IEC 19796-1 standard and their relation to the eQETIC Model is presented as follows.

- **Needs Analysis:** this category has four sub-processes and suggests the initiation of the project or product, making the identification of stakeholders necessary to assess the objectives and demands. For the EQETIC model, these sub-processes are identified according to the Implementation Rule presented in the Management Common Entity of Sufficient Level. For example, to verify the analysis of the demand, the eQETIC Model presents the Implementation Rule (IRMA 100.1), which addresses

the need for a Strategic Plan for the institution and the needs of digital resources geared to the learning process.

- **Framework Analysis**: this category concentrates six sub-processes to address the structural issues for environment, human resources and financial resources, to execute the project and develop the product. For eQETIC Model, such aspects are considered in the Implementation Rules of the Management Common Entity, with the Groups of Implementation Rules GIRMA 101 and GIRMA 102, which correspond to part of these sub-processes, showing no rules binding environmental analysis to the product availability.
- **Conception/Design:** this category holds the largest number of associated sub-processes, eleven in total. It's related to the educational features in its conception and design, so that the product attains its learning, educational or training ends.These sub-processes consider the didactic and pedagogical issues associated to medias and technologies. Likewise, such sub-processes can be identified in the eQETIC Model, spread over three Common Entities: the Didactic-Pedagogical Common Entity, Management Common Entity and the Technology Common Entity; and the rules presented in the Sufficient, Intermediate and Global Improvement Levels of the eQETIC Model as detailed in Table 4.
- **Development/Production:** this category considers five sub-processes and covers the development and production of the product itself; it collaborates with the issues that must integrate to productive processes. In this sense, the eQETIC Model addresses the rules of Technology Common Entity which suggests that the institution has to have mechanisms and standards that regulate this sector: 1) the decision for acquiring or developing the product or the entire solution; 2) evidence that favored the decision for acquisition or development. The model treats these sub-processes with several Implementation Rules of the Technology Common Entity distributed by the three levels of the model.
- **Implementation**: this process category concentrates on five sub-processes that are related to the implementation of technology components that support learning, considering adaptation activities, activation and testing of technology resources to be organized for using. The correspondence of these sub-processes to the eQETIC Model can be verified according to the rules defined in the Technology Common Entity.
- **Learning Process**: with three sub-processes associated, this category discusses the use of the infrastructure for learning, that is, the learning process must occur with the defined infrastructure. For the eQETIC Model, this process can be considered from the Didactic-Pedagogical Common Entity, Evaluation Common Entity and Management Common Entity to conduct the learning process. These entities present the rules that are related to the implementation of the contents according to the principles of instructional design and cognitive process related to learning; they also address the aspects of evaluation considering pre-tests, summative and formative evaluations applied to the learning process.
- **Evaluation/Optimization**: this category comprises four sub-processes that proposes evaluation methods, linked to the product in use or operation. Likewise, the eQETIC Model presents the Technology, Management, and Evaluation Common Entities that present specific rules to the evaluation of technological infrastructure used in the learning process. This can be verified in several Implementation Rules (Table 4) belonging to the above three common entities and the three Improvement Levels defined by the eQETIC Model.

Table 4 shows the correlation of the processes and sub-processes of the Reference Model defined by the ISO/IEC 19796-1 standard with the Implementation Rules set in the eQETIC Model, for a detailed comparative analysis between these two models. Note that the analysis occurs from the processes categories presented in the Reference Model of ISO/IEC 19796 part 1.

Table 4. Correlation of Sub-Processes of ISO/IEC 19796-1 Standard and the Implementation Rules of the eQETIC Model

Summary of mapping that correlates ISO/IEC 19796-1:2005 standard and the eQETIC Model		
Process/Sub-process ISO/IEC 19796-1:2005	**Strong relationship with eQETIC Model**	**Critical relationship between models**
1. Needs Analysis NA.1 Initiation NA.2 Stakeholder Identification NA.3 Definition of objectives NA.4 Demand analysis	Implementation Level: Sufficient Common Entity: Management Implementation Rules:IRMA 100.1, IRMA 101.1, IRMA 101.3, IRMA 102.1.	For the eQETIC Model, there is no specific Implementation Rule regarding demand analysis; however, the model presents the requirement of a Strategic Plan for the institution, regarding its educational products and services based on digital technologies.
2. Framework Analysis FA.1 Analysis of the external context FA.2 Analysis of staff resources FA.3 Analysis of target groups FA.4 Analysis of the institutional and organizational context FA.5 Time and budget planning FA.6 Environment analysis	Implementation Level: Sufficient Common Entity: Management Implementation Rules: IRMA 101.2, IRMA 102.1, IRMA 102.2, IRMA 102.3, IRMA 102.5.	There are no Implementation Rules for the eQETIC Model suggesting the analysis of external context and environmental analysis.
3. Conception / Design CD.1 Learning objectives CD.2 Concept for contents CD.3 Didactical concept / methods CD.4 Roles and activities CD.5 Organizational concept CD.6 Technical concept CD.7 Concept for media and interaction design CD.8 Media concept CD.9 Communication concept CD.10 Concept for tests and evaluation CD.11 Concept for maintenance	Implementation Level: Sufficient Common Entity: Didactic-Pedagogical Implementation Rules: IRDP 100.1, IRDP 101.1, IRDP 104.1, IRDP 105.1, IRDP 106.1, IRDP 108.2, Common Entity: Management Implementation Rules: IRMA 102.1, IRMA 102.3, IRMA 102.5 Common Entity: Technology Implementation Rules: IRTE 101.1, IRTE 102.1, IRTE 102.3, IRTE 103.1, IRTE 104.1. Implementation Level: Intermediate Common Entity: Didactic-Pedagogical Implementation Rules: IRDP 202.1 Common Entity: Technology Implementation Rules: IRTE 200.1. Implementation Level: Global Common Entity: Technology Implementation Rules: IRTE 300.1, IRTE 300.2	-
4. Development / Production DP.1 Content realization DP.2 Design realization DP.3 Media realization DP.4 Technical realization DP.5 Maintenance	Implementation Level: Sufficient Common Entity: Technology Implementation Rules: IRTE 101.1, IRTE 101.2, IRTE 102.1, IRTE 102.2. Implementation Level: Intermediate Common Entity: Technology Implementation Rules: IRTE 200.1. Implementation Level: Global Common Entity: Technology Implementation Rules: IRTE 300.2	The eQETIC Model addresses the development and production of technological resources in order to treat the decision between 'building' and 'buying' the technological apparatus necessary for the learning process. This analysis is not required by ISO/IEC 19796-1.
5. Implementation IM.1 Testing of learning resources IM.2 Adaptation of learning resources IM.3 Activation of learning resources IM.4 Organization of use IM.5 Technical infrastructure	Implementation Level: Sufficient Common Entity: Technology Implementation Rules: IRTE 101.1, IRTE 102.1.	The eQETIC Model considers that the Technological System is established, but does not have Implementation Rules that deal with the implementation of technological resources in detail.
6. Learning Process	Implementation Level: Sufficient	The eQETIC Model predicts an

LP.1 Administration LP.2 Activities LP.3 Review of competency levels	Common Entity: Didactic-Pedagogical Implementation Rules: IRDP 108.1, 108.2, Common Entity: Management Implementation Rules: IRMA 102.4, IRMA 102.5, IRMA 103.1 Common Entity: Evaluation Implementation Rules: IREV 100.1. Implementation Level: Intermediate Common Entity: Didactic-Pedagogical Implementation Rules: IRDP 200.1. Common Entity: Evaluation Implementation Rules: IREV 200.1. Implementation Level: Global Common Entity: Didactic-Pedagogical Implementation Rules: IRDP 300.1.	Implementation Rule that requires the diagnostic evaluation of the learner as well as requiring specific criteria to be established to address formative and summative evaluation. The ISO standard does not propose this type of specific criteria for evaluations.
7. Evaluation / Optimization EO.1 Planning EO.2 Realization EO.3 Analysis EO.4 Optimization / Improvement	Implementation Level: Sufficient Common Entity: Management Implementation Rules: IRMA 104.3, IRMA 105.1, IRMA 105.2. Common Entity: Evaluation Implementation Rules: IREV 102.1. Implementation Level: Intermediate Common Entity: Management Implementation Rules: IRMA 201.2, IRMA 201.3. Common Entity: Technology Implementation Rules: IRTE 200.1. Common Entity: Evaluation Implementation Rules: IREV 201.1, IREV 202.1, IREV 202.2. Implementation Level: Global Common Entity: Management Implementation Rules: IRMA 301.1, IRMA 301.2. Common Entity: Technology Implementation Rules: IRTE 300.1, IRTE 300.2. Common Entity: Evaluation Implementation Rules: IREV 301.1, IREV 301.2, IREV 301.3.	The eQETIC Model provides specific Implementation Rules that must determine the quality system, defining the indicators and method for collecting and preparing the indicators, as well as storage. It also sets rules that analyze and evaluate results in order to make the necessary improvements.

In Table 4, it is possible to observe the relationship between the two processes models; however, note that some of the rules of the eQETIC Model are not related to the sub-processes of Part 1 of ISO/IEC 19796; yet they may be related with other parts of the standard. For the 'Conception and Design' category, the models are observed not to present relevant critical points; and that for the other categories, there are points of divergence that can be critical in some cases, for example, the category 'Implementation', which treats the implementation of technological resources.

However, the relevant point is the category 'Development/Production', in which the eQETIC Model requires that processes are implemented to analyze the development or acquisition of technological resources, specifically the software product, which is a relevant component of the digital solutions that support educational activities.

6. Conclusion and Further Works

As can be verified, there are several frameworks issued by governments, associations, universities and researchers that aim to support the quality of digital educational solutions. Most of them have been available from 2000 onwards. However, comparative analysis based on process management was focused on two of these frameworks in order to see how they behave in relation to the process implementation to improve quality of digital educational solutions.

eQETIC Model uses the continuous process improvement approach, represented by Implementation Rules defined by the model and distributed by its three Improvement Levels. However, the Reference Model associated to the ISO/IEC 19796-1 standard defined its processes at a high level and does not have the same approach of continuous improvement.

Especially, observing Table 4 that relates the two processes models, it includes adherence in the categories of processes presented by the ISO/IEC 19796-1 standard and the eQETIC Model, yet there are practices of eQETIC Model that have no direct relationship with the sub-processes defined in part 1 of the ISO/IEC 19796, but it is possible to observe some other relationship in other parts of the standard.

This observation allows new researches related to the other parts of the ISO/IEC 19796 standard for a new comparative analysis, considering their sub-processes and the Implementation Rules provided by the eQETIC Model.

References

[1] Kay, R., & Knaack, L. (2005). Developing learning objects for secondary school students: A multi-component model. *Interdisciplinary Journal of e-Learning and Learning Objects*. Retrieved July 2, 2014, from http://www.ijello.org/Volume1/v1p229-254Kay_Knaack.pdf

[2] Shelton, K. (2011). A review of paradigms for evaluating the quality of online education programs. *Online Journal of Distance Learning Administration, 4(1)*. Retrieved July 02, 2014, from http://www.westga.edu/~distance/ojdla/spring141/shelton141.html.

[3] Rekkedal, T. (2006, May). State of the art report on distance learning and e-learning quality for SMEs. *E-Learning Quality for SMEs: Guidance and Counselings*. Retrieved November 11, 2011, from http://nettskolen.nki.no/in_english/elq-sme/ELQ-SMEStateofArt.pdf.

[4] Khan, H. B. (2004). The people-process-product continuum in e-learning: The e-learning P3 model. *Issues of Educational Technology, 44(5)*, 33-40.

[5] Marshall, S. J., & Mitchell, G. (2004). Applying SPICE to e-learning: An e-learning maturity model? *Proceedings of the Sixth Australasian Computing Education Conference (ACE2004)* (pp. 185-191).

[6] Rossi, R. (2013). *eQETIC: Modelo de Qualidade Para Soluções Educacionais Digitais* [*eQETIC: Quality Model for Digital Educational Solutions*]. São Paulo, Brazil: Editora Mackenzie.

[7] Cooper, J., & Fisher, M. (2002). Software acquisition capability maturity model version 1.03. Carnegie Mellon University/Software Engineering Institure, Pittsburgh, Technical Report 010.

[8] Humphrey, W. H. (1989). *Characterizing the Software Process: A Maturity Framework.* Pittsburgh, USA: Addison-Wesley Publishing Company.

[9] Standard Glossary of Software Engineering Terminology (p. 60). IEEE Standard STD-601.12-1990.

[10] Sanders, J., & Curran, E. (1995). *Software Quality A Framework for Success in Software Development and Support.* Great Britain: T. J. Press (Padstow) Ltd.

[11] Pawlowski, J. M. (2007). The quality adaptation model: Adaptation and adoption of the quality standard ISO/IEC 19796-1 for learning, education, and training. *Journal of Education Technology & Society, 10*, 3-16.

[12] Garvin, D. A. (1992). *Managing Quality: the Strategic and Competitive Vision*. Rio de Janeiro, Brazil: Qualitymark Ed.

[13] Software Engineering Institute (SEI). (2010). CMMI for Development, version 1.3., CMU/SEI-2010-TR-033. Retrieved July 02, 2014, from http://resources.sei.cmu.edu/library/asset-view.cfm?AssetID=9661.

[14] Association for Promotion of Brazilian Software Excellence (SOFTEX). (2012). MPS.BR-brazilian software process improvement – MPS general guide for software. Retrieved July 02, 2014, from http://www.softex.br/mpsbr.

[15] Nunes, V. B., Albernaz, J. M., & Nobre, I. A. M. (2009). Avaliação de cursos a distância. *Proceedings of 6th Brazilian Congresso of Distance Education: vol. 1* (pp. 1-10).

[16] Marshall, S., & Mitchell, G. (2002). An e-learning maturity model? *Proceedings of ASCILITE Australasian Society for Computers in Learning in Tertiary Education*. Retrieved July 2, 2014, from http://ascilite.org.au/conferences/auckland02/proceedings/papers/173.pdf

[17] International Organization for Standardization/International Electrotechnical Commission. (2005). ISO/IEC 19796-1:2005. Information technology - Learning, education, and training - Quality management, assurance and metrics - Part 1: General approach. international organization for standardization.

[18] Jacquemart, S. (2011). Educational lifecycle process assessment supporting ISO/IEC 19796-1. *Proceedings of Global Engineering Education Conference (EDUCON 2011)* (pp. 65-69). IEEE Publisher.

[19] Rossi, R., & Mustaro, P. N. (2011). A simplified quality model for e-learning development and evaluation. *Proceedings of e-Learn World Conference on e-Learning in Corporate, Governement, Healthcara & Higher Education* (pp. 878-883). Florida: EdITLib The Leading Digital Library Dedicated to Education & Information Technology.

[20] Barker, K. C. (2007). E-learnig quality standards for consumer protection and consumer confidence: A Canadian case study in e-learning quality assurance. *Journal of Education Technology & Society, 10,* 109-119.

[21] Guri-Rosenblit, S. (2005). 'Distance education' and 'e-learning': Not the same thing. *Higher Education, 49*, 467-493.

[22] Perkins, J. E. P. (2008). *Una Introducción a la Educación a Distancia*. Buenos Aires: Fundo de Cultura Económica.

[23] West, C. K., Farmer, J. A., & Wolf, P. M. (1991). *Instructional Design: Implications from Cognitive Science*. Boston: Pearson Custom Publishing.

[24] Gagné, R. M., Briggs, L. J., & Wager, W. W. (1992). *Principles of Instructional Design*. Flórida: Harcourt Brace Jovanovich.

[25] Dick, W., Carey, L., & Carey, J. O. (2005). *Systematic Design of Instruction*. Boston: Allyn & Bacon.

[26] The Institute for Higher Education Policy (IHEP). (2000). Quality on the line: Benchmarks for success in internet-bases distance education. Retrieved July 2, 2014, from http://www.ihep.org/assets/files/publications/m-r/QualityOnTheLine.pdf.

[27] European Network for Quality Assurance in Higher Education (ENQA). (2005). Standards and guidelines for quality assurance in the European higher education Area. Retrieved July 2, 2014, from http://www.enqa.net/files/ENQA%20Bergen%20Report.pdf.

[28] Moore, M., & Kearsley, G. (2011). *Educação a Distância: Uma Visão Integrada*. São Paulo: Cengage Learning.

[29] MEC/SEED Ministry of Education and Culture, Department of Distance Education. (2007). Quality becnhmarcks for distance education. Retrieved July 2, 2014, from http://portal.mec.gov.br/seed/arquivos/pdf/referenciaisead.pdf.

[30] Martínez, D. R., García, F. B., González, E. E., Molina, P. G., *et al*. (2011). *Gestión de Proyectos de*

e-Learning. México: Alfaomega Grupo Editor.

[31] Mauri, T., & Onrubia, J. (2011). Dimensiones e indicadores de la calidad de lós procesos formativos em línea: pautas para el análisis. In E. Barberá, T. Mauri, & J. Onrubia (Eds.), *Cómo Valorar la Calidad de la Enseñanza Basada en Lãs TIC: Pautas e Instrumentos de Análisis* (pp. 99-145). Barcelona: Editorial Graó.

[32] Project Management Institute. (2008). Project management body of knowledge (PMBOK guide). Pennsylvania, USA: Project Management Institute Publisher.

[33] Spanhol, F. J. (2009). Aspectos do gerenciamento de projetos em EAD. In F. M. Litto & M. Formiga (Eds.). *Educação a Distância: O Estado da Arte* (pp. 412-420). São Paulo: Pearson Prentice Hall.

[34] Elissavet, G, & Economides, A. (2003). An evaluation instrument for hypermedia courseware. *Journal of Education Technology & Society, 6(2)*, 31-44.

[35] Litto F. M., & Formiga, M. (2009). *Distance Education: State of the Art.* São Paulo, Brazil: Pearson Prentice Hall.

[36] Pera, S. M., Cervera, M. G., & Barado, S. I. (2007). E-tutoría: Uso de las tecnologias de información y comunicación para la tutoria acadêmica universitaria. In J. G. Carrasco & A. S. Pardo (Eds.), *Educación y Cultura Em la Sociedad de la Información* (pp. 31-54). Salamanca: Ediciones Universidad de Salamanca.

[37] Colomina, R., Rochera, M. J., & Naranjo, M. (2011). La perspectiva de los usuários sobre la calidad de los materiales educativos multimedia y los procesos formativos em línea: Usos, utilidad y valoración. In E. Barberá, T. Mauri, & J. Onrubia (Eds.), *Cómo Valorar la Calidad de la Enseñanza Basada en Lãs TIC: Pautas e Instrumentos de Análisis* (pp. 147-188). Barcelona: Editorial Graó.

[38] Polak, Y. N. S. (2009). A avaliação do aprendiz em EAD. In F. M. Litto & M. Formiga (Eds.), *Educação a Distância: O Estado da Arte* (pp. 153-160). São Paulo: Pearson Prentice Hall.

[39] Coll, C., & Engel, A. (2011). La calidad de los materiales educativos multimedia: dimensiones, indicadores y pautas para su análisis y valoración. In E. Barberá, T. Mauri, & J. Onrubia (Eds.), *Cómo Valorar la Calidad de la Enseñanza Basada en lãs TIC: Pautas e Instrumentos de anáLisis* (pp. 63-97). Barcelona: Editorial Graó.

[40] Zahran, S. (1998). *Software Process Improvement: Practical Guidelines for Business Success*. London, UK: Pearson Education Limited.

Rogério Rossi was born in São Paulo, Brazil, on March 8, 1969. He has a bachelor's degree in mathematics from the University Center Foundation Santo André (1991), and also has a master degree (1998) and PhD (2013) in electrical engineering, both from Mackenzie Presbyterian University that is located in São Paulo, Brazil.

He is in a postdoctoral program at the University of São Paulo and he is an adjunct professor for information technology and computer science courses of undergraduate programs in a University in São Paulo. He also has experience as a software quality professional using specific models like CMMI. He is the author of the book 'eQETIC: Quality Model for Digital Educational Solutions' published by Mackenzie editors. His currently field of study is related to the integration of complex systems, big data and the internet of things (IoT) and his previous research field is related to the software quality and quality for educational solutions based on digital technologies.

Dr. Rossi is a member of IACSIT (International Association of Computer Science and Information Technology), InSite (Informing Science Institute) and SBC (Brazilian Computer Society). He worked as a reviewer for InSite Conference'2013 and 2015, and e-Skills Conference'2014; as he also presented his papers in the InSite Conferences in Montreal, Canada (2012) and Porto, Portugal (2013).

Pollyana Notargiacomo Mustaro was born in São Paulo, Brazil. She was graduated in pedagogy (1992) from the University of São Paulo, an institution that also earned the title of master (1999) and doctor of education (2003). She is currently a professor at Mackenzie Presbyterian University, where she develops activities for research and teaching at the Computer Science College and electrical engineering & computer graduate course. Among her areas of research, the following themes stand out: instructional design, learning objects theory, learning styles, distance learning, podcasts, social media approaches and technological tools, social network analysis, hypertext theory, serious games, game culture studies, game design, and narratology.

Dr. Pollyana is a member of ACM (Association for Computing Machinery) and SBC (Brazilian Computer Society). She act as reviewer for Interdisciplinary Journal of e-Skills and Lifelong Learning (IJELL) and she also works on the scientific committee for reviewing papers for different conferences related to technology on education and digital games.