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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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The committee responsible for this document is ISO/IEC JTC 1 *Information technology*, Subcommittee SC 36, *Information technology for learning, education and training*.

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Introduction

New and emerging technologies are allowing learners to test and develop new knowledge for the creation of virtual experiments. By employing a collection of different technologies, virtual experiments are widely used within K-12 and higher education institutions (e.g. scientific laboratory experiments, technical training in medicine and biomedicine) and also within corporate training (e.g. flight simulators, manufacturing process control). Virtual experiments allow access to a wide range of different experiments, decrease the timeframe to complete experiments, eliminate hazardous situations, and reduce the costs of materials.

To facilitate the development of virtual experiment technology and specification integration, this Technical Report defines a virtual experiment framework that indicates how various standards and specifications can be combined to support the design, implementation, analysis and evaluation of virtual experiment systems. This Technical Report denotes the components and categories of related standards and specifications that can be used to support virtual experiment systems and learners. It illustrates how the components and categories can be structured to support implementations to improve reusability, reduce costs, and broaden applicability. It defines the framework of related virtual experiment standards and determines the mutual relations between different standards for designing, analysing and comparing different virtual experiment systems in order to promote the design and application of the virtual experimental components and systems. The framework of virtual experiment standards also helps to illustrate the categories of related virtual experiment systems and their relations in order to guide the development of other standard-setting work and normatively describe virtual experiment system.

Virtual experiments are typically accessed from an IT system, such as a learning management system (LMS), which provides the environment for learning. In addition to tools specifically tailored for learning, IT systems (such as LMSs) can also provide access to external tools. In a common scenario, an identity federation mechanism will automatically log into the external service but it is up to the learner whether to provide data inputs to the external tool. At the end of the activity, a score is returned to the IT system (e.g. LMS). This type of approach can be used to support activities, such as those involved in the scientific experimental approach, where there are requirements to repeat an experiment with a variety of parameters in order to assess their individual role in a process. There is a need to bridge the switch from the IT system (e.g. LMS) to an external virtual experiment tool, providing data inputs and recording outputs for further analysis. This Technical Report can be used to support these types of activities. In addition, this Technical Report provides specific considerations for the development of ITLET supportive technology and specification integration.

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Information technology — Learning, education and training — Virtual experiment framework

1 Scope

This Technical Report defines the framework for IT standards and specifications on virtual experiments supporting IT-enhanced learning, education and training. It is based on implementations of standards and specifications that are used to support virtual experiment, development, evaluation and management that rely on ITLET.

This Technical Report

— provides a framework that can be used for virtual experiment systems that rely on ITLET,

— determines the categories of different virtual experiment standards and specifications and their relationships to facilitate their integration,

— promotes the appropriate design and application of virtual experiment components so that IT systems that are being used are reusable, low cost, and more broadly applicable,

— indicates considerations to be taken into account when developing ITLET systems that are being developed or used to support virtual experiment systems,

— provides sample architecture of a virtual experiment system framework that can be used to support further development of virtual experiments,

— illustrates various roles that different actors can have at various points within the virtual experiment system,

— demonstrates how standards and specifications that support virtual experiments can be combined to form the basis for future work and implementations.

The following aspects are not addressed in this Technical Report:

— specifications of the implementation details of virtual experiment systems;

— accessibility;

— privacy;

— security.

2 Conformance

It is noted that it is possible for a virtual experimental instruction system to support more than one standard or specification by utilizing different combinations that include base standards, specifications, etc. The standards or specifications coordinate with circumstances or the virtual experiment instruction system that is configured separately to support specific standard or specification combinations.

This Technical Report provides the framework and objective to assist in the development of virtual experiments for information technology supporting learning, education, and training. This Technical Report also provides a proposed architecture of a system framework that is used to support the further development of virtual experiments. This Technical Report provides specific considerations for the development of ITLET supportive technology and for the integration of IT standards and specifications.

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3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
component cartridge
assembly of all the junior units based on specific rules to form a bigger component cell

3.2
remote access laboratory
laboratory in the physical world which can be accessed remotely

Note 1 to entry: Access to simulated equipment and virtual laboratories are excluded.

Note 2 to entry: A remote access laboratory enables learners to perform experiments at their own pace, time and location and allows teaching staff and learners to access laboratory facilities beyond their institutions.

3.3
virtual experiment
experiment based on multimedia, simulation and *virtual reality* (3.6), etc. which can assist or replace the operating segments of traditional, face-to-face experiments

3.4
virtual experiment component
smallest unit in a *virtual experiment* (3.3) which is composed of controllable and operable virtual experiment objects that may be reused

3.5
virtual laboratory
open networked instructional system based on web and *virtual reality* (3.6) technologies, which consists of virtual benches

3.6
virtual reality
artificial environment presented in the computer

4 Symbols and abbreviated terms

CP	Content Packaging
CC	Common Cartridge
LOM	Learning Object Metadata
LIS	Learning Information System
LMS	Learning Management System
MLR	Metadata for Learning Resources
QTI	Question and Test Interoperability
SCORM	Sharable Course Object Reference Model
SOA	Service-Oriented Architecture
XML	Extensible Markup Language

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