INTERNATIONAL STANDARD

ISO/IEC 23126

First edition
2021-04

Information technology for learning, education and training — Ubiquitous learning resource organization and description framework

Technologies pour l'éducation, la formation et l'apprentissage — Description de l'organisation et ressources d'apprentissage omniprésent

Reference number
ISO/IEC 23126:2021(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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.

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) or www.iec.ch/members_experts/refdocs).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents) or the IEC list of patent declarations received (see patents.iec.ch).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html. In the IEC, see www.iec.ch/understanding-standards.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

Ubiquitous learning is becoming increasingly prevalent. Ubiquitous learning makes it possible for students to learn anything, at anytime, anywhere, using any learning device. To support ubiquitous learning for learners, a ubiquitous learning support model should be constructed to provide ubiquitous services. The model consists of four parts: user interface; sensor layer; educational cloud system; and learning resources and services (Figure 1). During the learning process, the user interface detects learners' learning status, logs, interactions and personal information in the real learning context through the sensor layer. Subsequently, the educational cloud system conducts computing and analysis before providing learners with adaptive learning resources and services (see Annexes A, B and C).

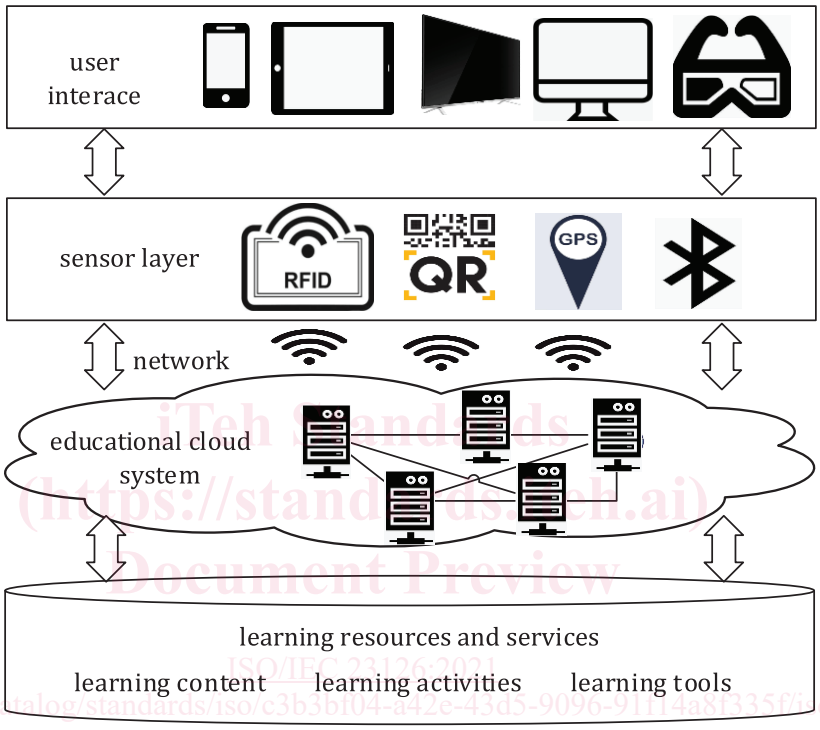

Figure 1 — Ubiquitous learning support model

Learning resources and services are central to learners' learning processes. However, learners' learning contexts can change as learners start and continue learning at different points across time and location. Under these circumstances, learners need adaptive resources and services to achieve effective learning. Traditional learning resources are designed and developed by experts for specific contexts. In some cases, the content is mostly static and cannot dynamically change to meet the diverse needs of learners who are accessing content in different environments. In addition, learners can encounter some difficulties as they learn specific topics. Related experts, peers or resources supporting the learning of the topic can be helpful for learners to expand their knowledge and knowledge-related connections. As time passed, learners can also contribute to current knowledge and thus promote the updating or evolution of knowledge while they achieve even higher-level knowledge. In order to make the learning process effective, it is important to provide learners with continuously evolving resources:

a) Learning resources should have the ability to adapt to different learners' needs under different learning contexts.

b) Learning resources should support the interactions not only between learners and resources, but also the interactions among learners and among resources.

c) Learning resources should evolve according to the contribution of learners or new knowledge so that they can be continuously adapted for learners with diverse needs.

d) In order to support personalized learning, dynamic and distributed resource aggregation service should be provided to learners with different learning requirements.

In summary, the ubiquitous learning support model needs to support diverse contexts, rich social interactions, continuous evolution and dynamic aggregation of knowledge. To that end, learning resources are the most important part for realizing the adaption of the learning process. In order to support that adaption, not only experts but also learners should be involved in the co-construction of learning resources. During the resource construction, resources should align with the contextual, social, evolvable and dynamic aggregated features. And in order to make the resources constructed by different contributors align with those features, a standardized guideline is needed for co-construction. However, existing standards for learning resources design and development focus on different aspects of static learning resources in terms of topic, description, related subjects, contributor and so on, and there is no description of the contextual, social, evolvable and dynamic aspects. In order to support these aspects, this document offers a ubiquitous learning resource organization and description framework, which is also referred to as a "learning cell framework". This document provides a description of the main framework for ubiquitous learning resources. It does not provide detailed definition.

Information technology for learning, education and training — Ubiquitous learning resource organization and description framework

1 Scope

This document specifies a framework to describe and organize learning resources in ubiquitous learning. It provides features to enable dynamic aggregation of resources in different learning contexts, in which the social interactions are recorded to facilitate social learning. The features that reflect the evolutionary history of resources based on learners' contributions are also defined.

The framework includes an aggregation model, content organization, context-aware learning services, and learning cell service provider.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
entity
any concrete or abstract thing that exists, did exist, or might exist, including associations among these things

EXAMPLE A person, an object, an event, an idea, a process, etc.

Note 1 to entry: Entity is a supportive element of identifier.

[SOURCE: ISO/IEC 2382:2015, 2121433, modified — domain of <databases> removed, notes to entry updated]

3.2
environment
<ITLET> context, surroundings or conditions in which a person learns, lives or operates

Note 1 to entry: Environment information includes time zones, geographical information, applicable norms and standards for telecommunication, technical implementation (firewalls, useable or allowed ports, bandwidth, file size restrictions, etc.), infrastructure support, current noise levels, and other environmental factors that may impact on delivery modes required by the learner.

3.3
identifier
sequence of characters capable of uniquely identifying an *entity* (3.1)

[SOURCE: ISO/IEC 19788-1:2011, 3.19, modified — notes to entry removed]

3.4
knowledge
human or organizational asset enabling effective decisions and action in context

Note 1 to entry: Knowledge can be individual, collective or organizational.

Note 2 to entry: There are diverse views on the scope covered within knowledge, based on context and purpose. The definition above is general as to the various perspectives. Examples of knowledge include insights and know-how.

Note 3 to entry: Knowledge is acquired through learning or experience.

[SOURCE: ISO 30401:2018, 3.25]

3.5
knowledge cloud
collection of *learning cell* (3.7) and *knowledge cluster* (3.6) aggregated semantically based on several related or similar topics to satisfy particular requirements for learning

3.6
knowledge cluster
collection of two or more *learning cells* (3.7) aggregated semantically based on a specific topic

Note 1 to entry: Knowledge cluster is a supportive element of knowledge cloud.

Note 2 to entry: Knowledge cluster can be involved in learning communities to support learners' learning.

3.7
learning cell
dynamic structure for ubiquitous *learning resource* (3.13), which defines the basic elements and their relations, and provides a personalized presentation [*learning cell entity* (3.9)] to support the diverse needs of learners based on a specific learning objective

Note 1 to entry: The structure is context adaptive, involves social factors to support social learning, realizes the evolution based on learners' interactions and contributions, and can dynamically aggregate content, based on the contextual, social and evolvable information and present learners with personalized *learning cell entity* (3.9).

Note 2 to entry: Learning cell has four characteristics: contextual, social, evolvable and dynamic aggregated.

Note 3 to entry: Learning cell is a supportive element of knowledge cloud and knowledge cluster.

Note 4 to entry: Learning cell can be involved in learning communities to support learners' learning.

3.8
learning cell container
space where *learning resource* (3.13) or *learning ingredient* (3.11) is extracted from different learning systems and managed according to specific topic or topics

Note 1 to entry: In this space, the resources or ingredients collected from the learning systems can be reorganized and retained in a well-structured manner.

3.9
learning cell entity
instance of a *learning cell* (3.7) that can be used in different learning contexts to support different learning needs

Note 1 to entry: A learning cell entity is a presentation of a learning cell within a specific context.

3.10
learning community
area in which learners with the same interests can interact, access, and share information using resources such as *learning cell* (3.7) and *knowledge clusters* (3.6) to achieve specific learning objectives or outcomes

3.11
learning ingredient
component that can be used to form a *learning cell* (3.7), such as content, activity, tools and metadata

Note 1 to entry: A learning ingredient is a supportive element of learning cell.

3.12
learning objective
description of a goal of training or learning in terms of the knowledge, skills or performance expected of a learner

Note 1 to entry: A learning objective may also be referred to as a learning outcome.

Note 2 to entry: A learning objective is often defined based on the requirements of a curriculum criterion or a set of criteria.

[SOURCE: ISO/IEC 2382-36:2019, 3.5.2, modified — notes to entry added]

3.13
learning resource
resource (3.17) used for learning, education and training

[SOURCE: ISO/IEC 19788-1:2011, 3.20]

3.14
obligation status
<attribute> indication of whether or not a value for the attribute is to be provided

[SOURCE: ISO/IEC 19788-1:2011, 3.20, modified — note to entry removed]

3.15
person
person class
any *entity* (3.1) which is a natural or legal person

3.16
personal learning space
place for a learner to manage his/her learning profile, assignments, interactive data, evaluation and associated information generated during the learning process

Note 1 to entry: This personal space may be shared with learner's permission to instructor(s), other learner(s), and other systems to support further learning of the individual, other individuals, and the system itself. Learner data and interactions are private in the personal space and learner consent is required to share this data.

3.17
resource
entity (3.1) that can be identified and referenced by an unambiguous and stable *identifier* (3.3) in a recognized identification system

[SOURCE: ISO/IEC 19788-1:2011, 3.30]

3.18
resource class
set of *resources* (3.17) that can be identified by listing or description of boundaries and meaning and whose properties and behaviour follow the same rule

Note 1 to entry: A resource class has the following attributes:

— Identifier.

— Name.

— Definition.

— SubclassOf [multiple inheritance].

— Note.

EXAMPLE Learning Resources (set of all learning resources), Persons (set of all Persons), Rights (set of all rights objects), and Documents (set of all documents).

[SOURCE: ISO/IEC 19788-1:2011, 3.31]

3.19
sharable learning cell description interface
SLDI
interface to provide registration and open access for services and resources in different learning systems

3.20
social knowledge network
SKN
network constituted by person, knowledge and their relations based on specific knowledge that supports learners' knowledge and peer discovery during the ubiquitous learning process

Note 1 to entry: A social knowledge network represents all the nodes that have a relationship with specific knowledge, and the nodes include person nodes and knowledge nodes.

3.21
ubiquitous learning
learning that is stimulated and supported through diverse channels and always readily accessible

[SOURCE: ISO/IEC TS 29140:2020, 3.15]

4 Abbreviated terms

LOM learning object metadata

MLR metadata for learning resources

ITLET information technology for learning, education and training

API application programming interface

5 Learning cell framework overview

5.1 General

The learning cell framework supports learners' ubiquitous learning. An overview of the ubiquitous learning model supported by the learning cell framework is provided in Figure 2, which illustrates the process for learners to acquire ubiquitous learning services in different situations. In this model, the situations (classroom, home, bus station and so on) where learners' learning requirements rise are defined. In different situations, learners can interact with learning cells embedded in different devices.

During this process, the learning cell service will detect learners' personalized information and learning status with various sensors. Detected information will be sent to the educational cloud computing centre for analysis. The educational cloud computing centre conducts analysis and decides learners' current states and needs. The needs include several kinds of personalized services, such as knowledge network, social network, and other learning services (learning tools, learning activities, cognitive map and so on). These services will be dynamically collected, aggregated with the form of the learning cell and then present to learners with an adaptive presentation.

After these processes, learners can acquire adaptive learning support. With learners' further interactions, the learning cell can also be enriched. This document defines the core factors in a ubiquitous learning resource, and these constitute the organization and description framework.

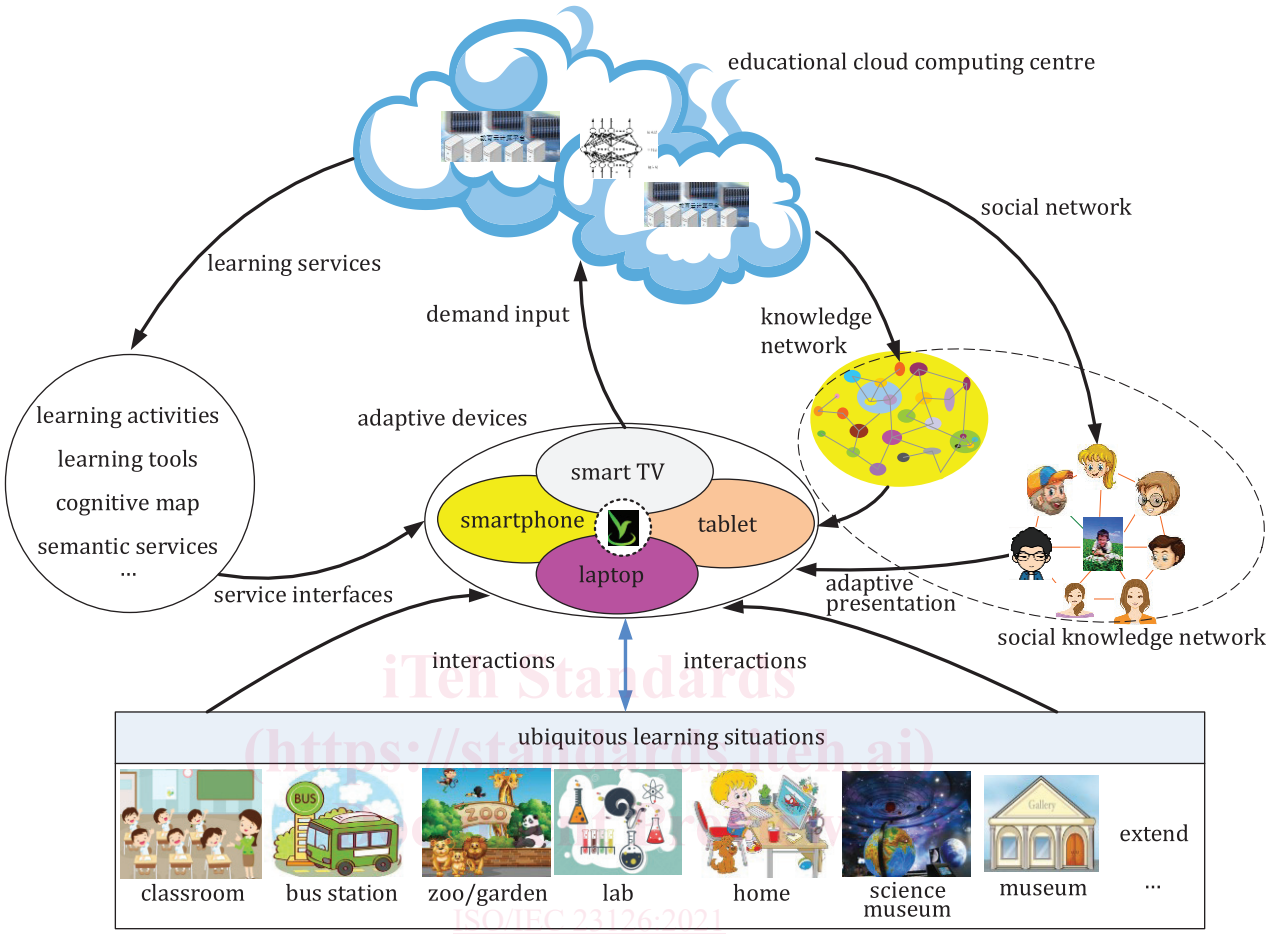

Figure 2 — Ubiquitous learning supported by the learning cell framework

The learning cell framework defines the characteristics of learning resources, in which different situations are supported for contextualized learning. At the same time, social knowledge network is used to support social learning and learning activities can be used to help the progression of the learners and learning resources. At last, the learning resources can be dynamically aggregated from different sources. Moreover, the framework also provides a detailed introduction of how these characteristics are represented with specific properties. Subclauses 5.2 and 5.3 define the characteristics and components of the learning cell framework.

5.2 Characteristics of learning cell

The learning cell has four essential characteristics: contextual, social, evolvable, and dynamic-aggregated. These characteristics can help realize the previously mentioned resource requirements

Contextual: The learning cell provides a changeable and dynamic structure that can adjust the elements and their organization in the structure so as to support learners' learning under different contexts. After that learners in different contexts can access resources that are aligned with their contexts both in terms of structure and display. This means that the presentation of the resource will match the learners' contexts.

Social: The learning cell provides social elements in its structure. The social elements are presented to learners with the form of social knowledge network, which contains person nodes, knowledge nodes, and the relations among these nodes. The nodes and relations in the social knowledge network are

created by learners' social interactions with different knowledge and related person nodes, such as other learners. The interactions will be retained as the SKN and used for computing and analysis.

Evolvable: The learning cell defines elements to record the interaction history and aggregation history of resources during the learning process. The interaction history is based on the contributions of different learners and promotes the learning cell transformation from insufficient to sufficient, low-quality to high-quality. The control of this process will be realized by algorithms. Also, when new resources are created, they will be classified semantically by algorithm, and thus cluster to a higher-level resource with higher quality.

Dynamic-aggregated: The learning cell defines the aggregate process how a learning cell entity can be formed and presented to learners dynamically. Contextual information is the basic condition for realizing the dynamic aggregation. A computing centre in the learning cell first conducts data analysis based on the contextual information and decides the elements involved in the learning cell entity. Then the sequences or structure of different elements will be computed, thus aggregating the elements together in a well-ordered manner. Also, when the context changes, the learning cell will detect the change and conduct re-aggregation dynamically. In this way, the resource is dynamically aggregated.

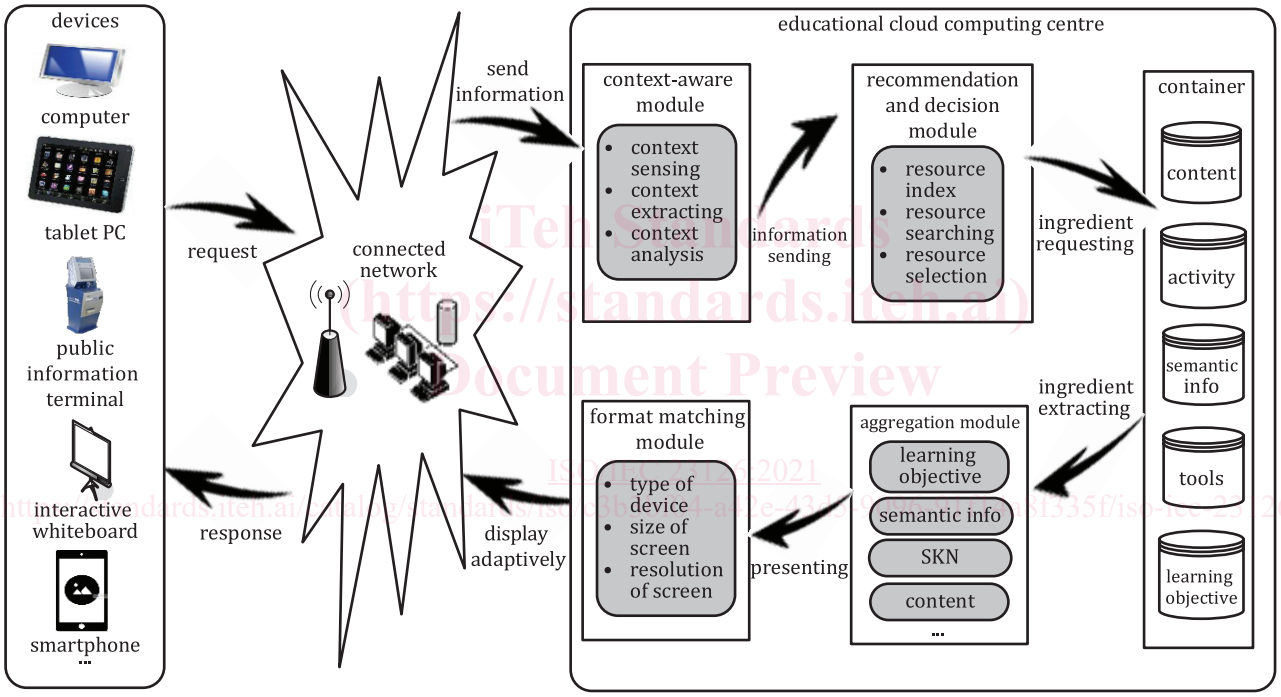

Figure 3 — Functions supported by learning cell framework

To realize these characteristics, this document defines how the system is supported by learning cell framework functions (see Figure 3). It includes three core elements: devices, connected network, and educational cloud computing centre. When ubiquitous learning begins, learners send their requirements through adaptive devices. Then the requests and related data collected by the sensors embedded in the environment are sent through the connected network to the educational cloud computing centre. After receiving the requested information, the context-aware module conducts analysis, and then transfers the analysed information to the recommendation and decision module. The recommendation and decision module are responsible for indexing, searching and selecting ingredients from the learning cell container, including learning objectives, content, activities, semantic information and cognitive network. Then the extracted ingredients are aggregated through the aggregation module into learning cell. Finally, the learning cell is displayed adaptively after format matching, such as matching type, size, and resolution of the device. Users can interact with the learning cell and promote the evolution of the learning cell.