TECHNICAL REPORT

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# Information technology for learning, education and training — Catalogue model for virtual, augmented and mixed reality content

*Technologies de l'information pour l'apprentissage, l'éducation et la formation — Modèle de catalogue pour les contenus en réalité virtuelle, augmentée et mixte*



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# Foreword

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This document was prepared by Joint Technical Committee ISO/IEC JTC1, *Information technology*, Subcommittee SC 36, *Information technology for learning, education and training*.

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# Introduction

Effective use of the characteristics of virtual, augmented and mixed reality (VR, AR and MR, respectively) content in education has growing importance. There are increasing numbers of VR/AR/MR educational resources and there are also VR/AR/MR resources that have been aligned with curriculum documents. One of the main challenges is to search for and find content that is appropriate for the curriculum. However, lack of adequate description of such characteristics in a standard way makes it difficult for users to find suitable content.

This document describes a catalogue model for virtual, augmented and mixed reality content that can be linked to curriculum and achievement standards information. The curriculum catalogue metadata is designed to support search and retrieval of VR/AR/MR content in activities in education.

For teachers and learners, it supports:

— searching and selecting VR/AR/MR content related to curriculum;

— exploring specific features of the content (type, price, etc.) at a glance;

— finding technical information for the effective use of the VR/AR/MR content.

For the institution, it supports:

— managing the VR/AR/MR content related to the curriculum;

— adopting the VR/AR/MR content with priority based on the catalogue model.

For curriculum developers, it supports:

— comparing and identifying VR/AR/MR content for review to determine relevance to the curriculum.

For content providers, it supports:

— exploring and reviewing content to determine relevance and potential usefulness of content development initiatives;

— providing tools to gather reviews and feedback regarding content developed.

For device vendors, it supports:

— providing support for feedback regarding performance, technical configuration (e.g. platform, infrastructure), accessibility/usability information, and other improvements needed.

This document provides related catalogue models and specific elements of the catalogue model to use VR/AR/MR content for activities in education. However, specification of the catalogue model using the ISO/IEC 19788 series is not in the scope of this document.

# Information technology for learning, education and training — Catalogue model for virtual, augmented and mixed reality content

## 1 Scope

This document describes how to search for virtual reality (VR), augmented reality (AR) and mixed reality (MR) content through a curriculum catalogue based on curriculum and achievement standards information. The curriculum catalogue metadata is defined in order to search for educational VR and MR content information.

## 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**
**curriculum**
formally structured statement describing learning outcomes aligned to specific topics or units of learning, typically spanning all subject areas offered by an educational entity

**3.2**
**virtual reality**
**VR**
artificial environment presented using computer technologies

Note 1 to entry: Virtual reality has a high level of immersiveness, fidelity of information representation, and degree of active learner participation compared to other forms of mixed reality.

[SOURCE: ISO/IEC TR 18121:2015, 3.6]

**3.3**
**augmented reality**
**AR**
virtual objects superimposed upon or composited with the real world

Note 1 to entry: Virtual and real-world objects co-exist in augmented reality systems.

**3.4**
**mixed reality**
**MR**
display continuum in which both real and virtual images are combined in some way and in some proportion

Note 1 to entry: Augmented reality (AR) and virtual reality (VR) are considered to be on the mixed reality continuum.

## 4 Abbreviated terms

| | |
|---|---|
| ADDIE | analyse, design, develop, implement, evaluate |
| LET | learning, education and training |

## 5 Background

### 5.1 Metadata for digital content

Metadata, as data that provides information about other data, can describe all sorts of digital content such as audio files, pictures, videos, games and learning resources. Metadata can be applied to not only a digital object but also groups of related objects or collections of items so that they can be managed and organized for users to better discover, evaluate, retrieve, use and share the content as needed. Application of metadata is controlled by use of schemas consisting of defined fields for specific types of information, and thus a metadata scheme provides a consistent and interoperable way to manage the lifecycle of metadata by specific communities and sectors. Annex A describes related metadata schemes for digital content for reference purposes: the ISO/IEC 23005 series for technical metadata (MPEG-V, described in Reference [17]), metadata encoding and transmission standard (METS)[15] for the library sector, VRA Core[18] for the cultural heritage sector, CRMdig[12] for a provenance metadata, and video game metadata schema (VGMS)[6] for descriptive and discovery metadata. The various types of metadata and different metadata schemes can be combined to support diverse requirements.



### 5.2 Characteristics of VR/AR/MR content

In order to use learning content through technologies to support LET, it is necessary to be able to search and read learning content information. This requires metadata that enables the interoperability of educational content and the ability to perform comparisons and searches between LET content. The ISO/IEC 19788 series provides an extensible approach that can be used to support these efforts, and similar types of initiatives can be used as well.

VR, AR or MR technology are increasingly applied to create content in various domains including learning, education and training. However, the existing standards are insufficient to describe learning content that uses VR/AR/MR technologies. This is due to characteristics of the bi-directional interaction inherent in VR/AR/MR technology and requirements emerging from the utilization of new types of media devices. In VR/AR/MR content, the users interact with content directly using their heads and hands and receive the visual and auditory information back through VR/AR/MR devices such as the headset. The VR headset provides a larger field of view than monitors do, and thus the actions become more intuitive and direct.

VR/AR/MR content relies heavily on interactions with users in contrast to one-way delivery of content in non-VR/AR/MR contexts. The interactions might involve not only interaction with content but also with other users connected to the network. Approaches and methods outlined in the ISO/IEC 19788 series can be extended to support the diverse interactions, properties and effective use of VR/AR/MR content. Especially, VR/AR/MR content depends on the visual and auditory devices and movement tracking sensors. The content through digital media can be influenced by the hardware performance and configurations like resolution or eye-tracking function. Therefore, additional properties that

 

consider these characteristics need to be incorporated in the metadata of VR/AR/MR-based educational content.

## 5.3 Actors and roles

In order to identify required metadata for VR/AR/MR content in LET, a thorough collection and analysis of use-cases is required. This document begins by identifying related stakeholders not included in the traditional metadata and defining relationships among them. Such stakeholders are modelled as actors as shown in Figure 1. Each actor is represented by a circle, with arrows showing the message that are passed to the actor through the interaction. Learners, teachers or curriculum developers could belong to an institute, and thus interactions with those actors can be indirect through the institution as shown as dotted lines in Figure 1.

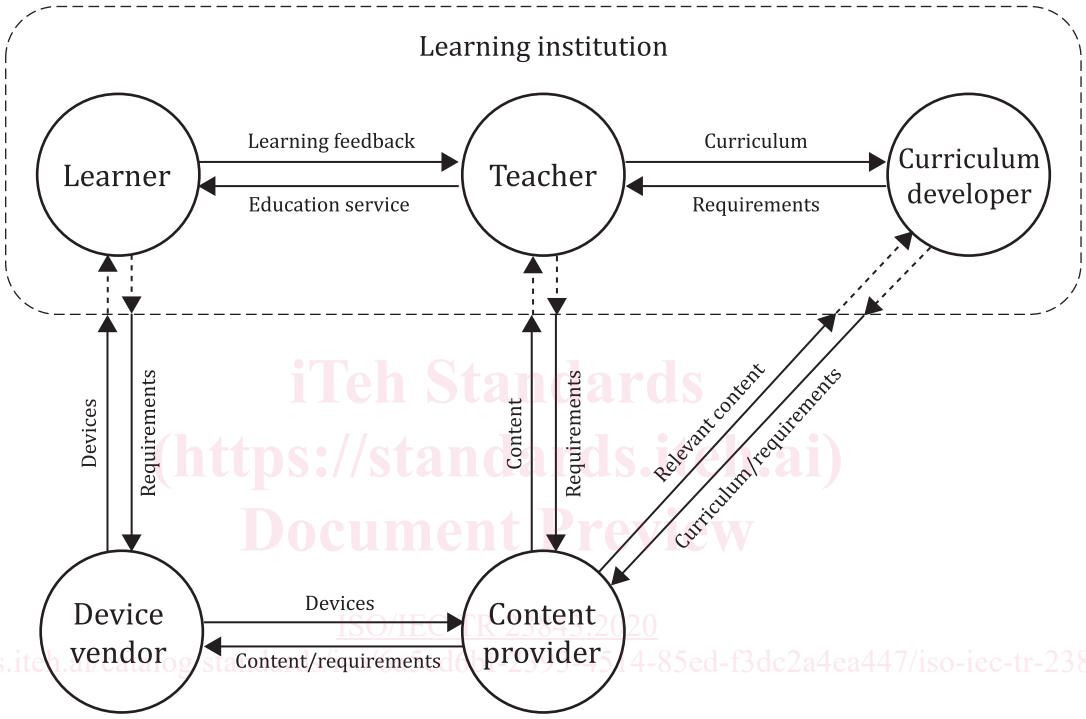


**Figure 1 — Actors and interactions**

Requirements for metadata for learning resources in online contexts prior to VR/AR/MR technologies considered the content provider and curriculum developer. However, in VR/AR/MR contexts, the role of device vendor is to provide devices with required performance for VR/AR/MR content. Device performance metadata can be used not only for learners or teachers to select learning content in a learning environment, but also for a content provider to develop content. Note that such characteristics are similar to the ecosystem of other multimedia content, such as MP3s, in which the content's producers and consumers, players and applications play parts. In addition, if MP3s are considered as an example, there are various metadata used to support the retrieval and data interoperability of audio content. ISO 16684-1[4] specifies the creation, processing and interchange of standardized and custom metadata for digital documents and data sets. XMP standardizes a data model, a serialization format and core properties for the definition and processing of extensible metadata. It also provides guidelines for embedding XMP information into popular image, video and document file formats, such as MPEG4. ID3[5] is a de facto standard that is used as a metadata container that is often used in conjunction with the MP3 audio file format. It allows the title, artist, album, track number and other information about the file to be stored in the file itself. ID3 is used for interoperability such as album information to which an audio file belongs, content image information such as linked image, copyright, content characteristic information such as compression method or encryption method, file type, key position for synchronizing with lyrics, recommended buffer size information, etc. This information is considered not only the consumer's use-case for search and playing audio files, but also the interoperability

aspects for providing an optimized content playback environment for the audio player application. The MP3 example demonstrates that different types of metadata can be used for each type of content. This means that an VR/AR/MR catalogue model needs to support a variety of different types of content as well as associated metadata.

## 5.4 Video games as the reference model

As noted earlier, VR/AR/MR content has different aspects in that users and media interact in both directions, unlike the various multimedia content. This means that users need to consider additional types of interactions with content, and the closest form of media that can be referred to is the video game. Video games use complex multimedia formats that include both music, video and narrative to provide interactions with users.

Information School in University of Washington has made efforts to define a metadata schema for games and released the video game metadata schema (VGMS) Version 4.0[6] in 2017. VGMS has been developed to advance the cataloguing and classification of digital games as cultural artefacts and support the use of games in education and science. This metadata schema defines not only the information above, but also various types of items that can be included in other media such as networked feature, connectivity, special hardware, or content related information such as theme and mood.

## 5.5 Application of game metadata

Our approach is to adopt VGMS as the basis of the metadata for VR/AR/MR content and then to evaluate the applicability of the game metadata in terms of the actions identified above. Our preliminary effort is to identify the relevance of the VGMS properties to the actors of VR/AR/MR content. Table 1 lists VGMS properties in categories and associates the relevance to the actors of VR/AR/MR content.



**Table 1 — VGMS properties in categories**

| Type | Property name | Actors | | | | |
|---|---|---|---|---|---|---|
| | | Leaner | Teacher | Curriculum developer | Content provider | Device vender |
| Game entity | Game title | ✓ | ✓ | ✓ | ✓ | |
| | Gameplay genre | ✓ | ✓ | ✓ | ✓ | |
| | Narrative genre | ✓ | ✓ | ✓ | ✓ | |
| | Summary | ✓ | ✓ | ✓ | ✓ | |
| | Theme | ✓ | ✓ | ✓ | ✓ | |
| | Setting | ✓ | ✓ | ✓ | ✓ | |
| | Mood | ✓ | ✓ | ✓ | ✓ | |
| | Mechanic | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Progression | | ✓ | ✓ | ✓ | |
| | Protagonist | | ✓ | ✓ | ✓ | |
| | Trope | | ✓ | ✓ | ✓ | |
| | Game note | ✓ | ✓ | ✓ | ✓ | |