STANDARDS

# IEEE Standard for Augmented Reality Learning Experience Model

Developed by the

**Learning Technologies Standards Committee**
of the
**IEEE Computer Society**

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**IEEE SA Standards Board**

**Abstract:** Augmented reality (AR) promises to provide significant boosts in operational efficiency by making information available to employees needing task support in context in real time. To support implementations of AR training systems, in this document, an overarching integrated conceptual model is proposed to describe interactions between the physical world, the user, and digital information, the context for AR-assisted learning and other parameters of the environment. Two data models are defined, as well as their binding to XML and JSON for representing learning activities (also known as "employee tasks and procedures") and the learning environment in which these tasks are performed (also known as the "workplace"). The interoperability specification and standard is presented in support of an open market where interchangeable component products provide alternatives to monolithic AR-assisted learning systems. Moreover, the creation of experience repositories and online marketplaces for AR-enabled learning content is facilitated. Specific attention is given to reuse and repurposing of existing learning content, as well as to catering to "mixed" experiences combining real-world learner guidance with the consumption (or production) of traditional contents such as instructional video material or learning apps and widgets.

**Keywords:** augmented reality, e-learning, IEEE 1589™, immersive learning environment, learning activity, learning experience, performance support, mixed reality, workplace training

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## Introduction

The next generation of performance support systems and tools for learning at the workplace is likely to be delivered in augmented reality (AR). While there are many impressive prototypes and bespoke applications, interoperability has been neglected so far and standards for creating and converting urgently needed AR training content at scale are missing. To address this gap, the IEEE Computer Society provides this standard for an AR Learning Experience Model (ARLEM) as a remedy, elaborated by Working Group P1589.

The standard provides a data format for the enrichment and exchange of AR learning content, consisting at its core of an activity description language and a workplace model.

It is built for describing AR learning experiences such as bringing a handbook to life or hands-free operator training with smart glasses. For example, astronauts can be trained using an AR learning experience while on the ground or when in space, practicing how to perform an assembly procedure of a temporary stowage rack. In this case, the AR training system executes the learning activity represented, using the activity description language set out in this standard. To provide procedural guidance live and in context, the attention of the astronauts in training can be directed to relevant parts of the rack and wall mount by overlaying visual instruction and 3D animations, explaining step by step what needs to be done.

Another example can be found in aeronautics, where service technicians in training build up expertise in how to rig an aircraft engine. For this, the AR training system provides activity guidance on how to handle and adjust the various components associated with the control system to optimize engine performance.

To make yet another example, doctors in training can practice the diagnostic procedure for detecting pulmonary embolism, being guided and receiving explanatory support for different conditions and the way these conditions manifest with different imaging technologies using an AR training system.

# Contents

# IEEE Standard for Augmented Reality Learning Experience Model

## 1. Overview

### 1.1 Scope

This standard defines two description languages for expressing augmented reality (AR) learning experiences. This document shows how to represent activities conducive to developing or upgrading knowledge, skills, abilities, and other characteristics in a standardized interchange format. The interchange format links the representation of learning activities with their environment and context in the actual (or simulated) workplace, classroom, or other environment in which an AR-enhanced training system may execute them. The specification aims to lower entry barriers for authoring of learning experiences that involve interaction with the real world, sensors, computer vision, and web applications.

### 1.2 Purpose

This standard for augmented reality learning experience models (ARLEMs) provides an overarching integrated conceptual model and the corresponding data model specifications for representing activities, learning context, and environment (aka "workplace"), while linking with other data model components needed for AR-enhanced learning activities.

The standard distinguishes slow-changing data for environment description from fast-changing data for step-by-step guidance. It defines the required data models and modeling languages and their bindings to Extensible Markup Language (XML; see XML 1.0) and JavaScript Object Notation (JSON; see ECMA-404).[1]

The purpose of this standard is to support the discovery, retrieval, transfer, and execution of AR-enabled learning content, thereby facilitating the creation of repositories and online marketplaces.

Finally, the standard supports reuse and repurposing of existing (learning) content in "mixed" experiences that combine real-world guidance with traditional media such as instructional video material or existing web applications and widgets.

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[1] Information on references can be found in Clause 2.