Experience API (xAPI) and Serious Games: the xAPI-SG Profile

e-UCM Research Group
www.e-ucm.es

Iván Martínez Ortíz, Baltasar Fernández Manjón, Manuel Freire Morán, Cristina Alonso Fernández, Iván José Pérez Colado, Antonio Calvo Morata, Víctor Manuel Pérez Colado

Experience API (xAPI)

Experience API (xAPI) is a specification to collect data about the actions of a person in a learning environment. This standard was created by a community lead by **ADL**.

Any learning action or activity can be traced using xAPI. Traces reported in xAPI are called *statements* and they include:

- an ***actor***: who performed the action
- a ***verb***: the action performed
- an ***object***: the target of the action

xAPI statements may also include additional fields such as the timestamp of the action or its results.

Experience API (xAPI)

Sample xAPI trace:

actor
verb: answered
object: activityone
result: score=10 and success=true

```
{
    "timestamp": "2019-01-07T11:10:00+01:00",
    "actor": {
        "mbox": "mailto:e-ucm@ucm.es",
        "objectType": "Agent"
    },
    "verb": {
        "id": "http://adlnet.gov/expapi/verbs/answered",
        "display": {
            "en-US": "answered"
        }
    },
    "object": {
        "id": "http://adlnet.gov/expapi/activities/activityone",
        "definition": {
            "name": {
                "en-US": "Activity One"
            },
            "description": {
                "en-US": "Activity one description"
            }
        },
        "objectType": "Activity"
    },
    "result": {
        "score": {
            "raw": 10
        },
        "success": true
    }
}
```

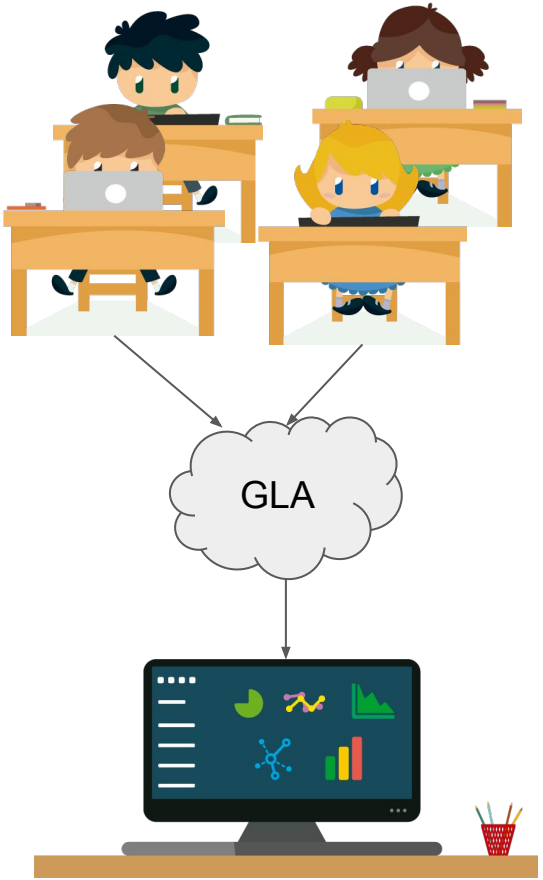
xAPI trace creator:
https://adlnet.github.io/xapi-lab/

Serious Games and Learning Analytics

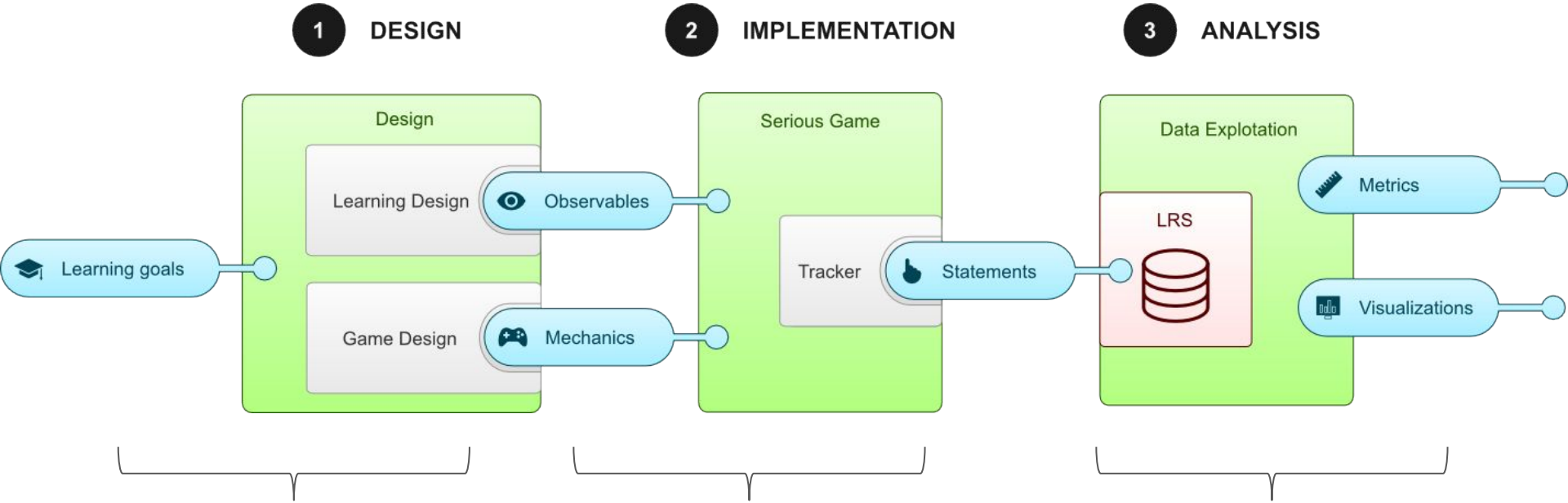
Serious Games are games with purposes beyond entertainment (teaching, changing attitudes or behaviours, raising awareness of an issue).

Learning Analytics is the field that aims to track, collect, analyze and report data about learners and their contexts, with the goal to improve the learning process.

Learning Analytics can also be applied to Serious Games, collecting data from in-game interactions and reporting useful information about players. This discipline is called **Game Learning Analytics (GLA)**.



Game Learning Analytics



What data is to be collected from the game and how it relates to learning goals

Which specific statements (e.g. in xAPI format) are to be tracked from the game containing that information

How the statements collected are to be analyzed and what information is to be reported and/or visualized

Experience API for Serious Games: xAPI-SG Profile

xAPI allows the implementation of ***profiles*** for particular contexts: a xAPI profile defines a vocabulary, extensions, statements templates and patterns for that specific domain.

The e-UCM Research Group in collaboration with ADL created the **Experience API for Serious Games Profile (xAPI-SG)**, a xAPI profile for the specific domain of Serious Games.

The xAPI-SG Profile defines a set of verbs, activity types and extensions, that are commonly needed in the context of serious games.

https://adlnet.gov/news/a-serious-games-profile-for-xapi

https://xapi.e-ucm.es/vocab/seriousgames

xAPI-SG Profile

The **xAPI-SG Profile** is the result of the implementation of an interactions model for Serious Games in xAPI.

The types of interactions that can be performed in a Serious Game, and are included in the profile, can be grouped based on the type of interactions and game objects that the interaction is performed over.

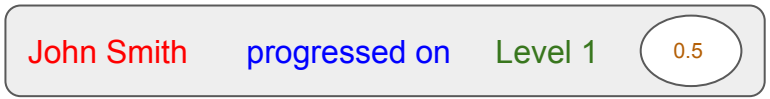
The following slides present some of these common interactions and game objects related with them, with example xAPI-SG statements.

- completables
- accessibles
- alternatives
- GameObjects

xAPI-SG: Completables

A **completable** is something a player can start, progress and complete in a game, maybe several times.

- Verbs: *initialized, progressed, completed*
- Types: *game, session, level, quest, stage, combat, storynode, race, completable*




```
{
    "actor": {
        "mbox": "mailto:john.smith@ucm.es",
        "name": "John Smith",
        "objectType": "Agent"
    },
    "verb": {
        "id": "http://adlnet.gov/expapi/verbs/progressed",
    },
    "object": {
        "id": "http://adlnet.gov/expapi/activities/Level_1",
        "definition": {
            "type": "https://w3id.org/xapi/seriousgames/activity-types/level"
        }
    },
    "result": {
       "extensions": {
            "https://w3id.org/xapi/seriousgames/extensions/progress": 0.5
        }
    }
}
```

xAPI-SG: Accessibles

An **accessible** is is a virtual space inside the game world a player can access or skip once or multiple times.

- Verbs: *accessed, skipped*
- Types: *screen, area, zone, cutscene, accessible*

John Smith skipped Intro video

```
{
    "actor": {
        "mbox": "mailto:john.smith@ucm.es",
        "name": "John Smith",
        "objectType": "Agent"
    },
    "verb": {
        "id": "http://id.tincanapi.com/verb/skipped",
    },
    "object": {
        "id": "http://adlnet.gov/expapi/activities/Intro_video",
        "definition": {
            "type": "https://w3id.org/xapi/seriousgames/activity-types/screen"
        }
    }
}
```

xAPI-SG: Alternatives

An **alternative** is a decision the player faces in the game, where the player has to choose only one option among several. Options can be unlocked.

- Verbs: *selected, unlocked*
- Types: *question, menu, dialog, path, arena, alternative*


```
{
    "actor": {
        "mbox": "mailto:john.smith@ucm.es",
        "name": "John Smith",
        "objectType": "Agent"
    },
    "verb": {
        "id": "https://w3id.org/xapi/adb/verbs/selected",
    },
    "object": {
        "id": "http://adlnet.gov/expapi/activities/CapitalOfSpain",
        "definition": {
            "type": "http://adlnet.gov/expapi/activities/question"
        }
    },
    "result": {
       "response": "Madrid"
    }
}
```

xAPI-SG: GameObjects

A **GameObject** is a game element the player can interact with.

- Verbs: *interacted, used*
- Types: *enemy, npc, item, gameobject*

John Smith used Health potion

```
{
    "actor": {
        "mbox": "mailto:john.smith@ucm.es",
        "name": "John Smith",
        "objectType": "Agent"
    },
    "verb": {
        "id": "https://w3id.org/xapi/seriousgames/verbs/used",
    },
    "object": {
        "id": "http://adlnet.gov/expapi/items/HealthPotion",
        "definition": {
            "type": "https://w3id.org/xapi/seriousgames/activity-types/item"
        }
    }
}
```

xAPI-SG Profile: Extensions

- ***health***: Used to represent the remaining health of the player (e.g., number of hearts, energy bar).
- ***position***: Used to represent the current position of the player inside the game world.
- ***progress***: Indicates the progress in a completable.

https://xapi.e-ucm.es/vocab/seriousgames

xAPI-SG: Custom interactions

The set of verbs and activity types defined in the **xAPI-SG Profile** allows to track data from any serious game without any information of the game **(game-independent).** The Profile aims to cover most of the possible interactions required in the particular context of SGs, so it can be used for most SGs.

However, there may be some situations where the Profile does not fit the specific requirements or characteristics of the serious game we want to collect data from. For these scenarios, **game-dependent** vocabulary can be defined to complement the xAPI-SG Profile, including new verbs, activity types or extensions, as needed.

For example, if tracking chat logs we could define a new target "*chat message*" with the verb "*send"*.

uAdventure Automatic xAPI-SG tracking

	Event	Cause	xAPI Type xAPI Verb	Target	Result R: response, S: success, Ext: extensions
targets	NPC Interaction	Player opens NPC actions menu	Character Interacted	NPC name	Ext: Action name
	Item Interaction	Player opens item actions menu	Item Interacted	Item name	Ext: Action name
accessibles	Scene access	Player enters a scene	Accessible Accessed	Scene id	
	Cutscene start	Player starts a cutscene	Cutscene Accessed	Cutscene id	
	Cutscene skip	Player presses skip	Cutscene Skipped	Cutscene id	Ext: Percent watched
alternatives	Exit selection in alternative type scenes	Player selects an exit in current scene, for menus or visual choices	(Alternative, Question Menu or Path) Selected	Exit Id	R: Arriving scene S: Based on exit conditions
	Dialog choice	Player selects one dialog option	Alternative Selected	Question Id	R: Response S: Correctness
completables	Task start	Player reaches a milestone	Completable Started	Completable Id	
	Task progress	Player reaches one of the milestones	Completable Progressed	Completable Id	Ext: Milestone progress value
	Task finish	Player reaches a milestone or completes all the steps	Completable Completed	Completable Id	R: Score from variable S: Based on conditions Ext: Time
	Game start	Player visits title	Game Started	Game name	
	Game progress	Accomplishment of any of the levels	Game Progressed	Game name	Ext: Progress as percent of levels (tasks) completed
	Game end	Milestone or all levels completed	Game Completed	Game name	R: Avg. score of all levels S: Based on conditions Ext: Time

Example xAPI-SG tracking

Countrix Q&A geography game to test tracking of xAPI-SG statements.
Example xAPI-SG trace of selecting a response in a question.


```
{
    "actor": {
        "name": "John Smith"
    },
    "verb": {
        "id": "https://w3id.org/xapi/adb/verbs/selected",
    },
    "object": {
        "id": "http://adlnet.gov/expapi/alternative/UnitedKingdomIsIn",
        "definition": {
            "type": "http://adlnet.gov/expapi/activities/question"
        }
    },
    "result": {
       "success": false,
        "completion": false,
       "response": "Asia"
    }
}
```

Example xAPI-SG tracking

Conectado game to raise awareness about bullying and cyberbullying.
Example xAPI-SG trace of interacting with a game object.


```
{
  "actor" : {
     "name" : "student1"
  },
  "verb" : {
     "id" : "http://adlnet.gov/expapi/verbs/interacted"
  },
  "object" : {
     "id" : "http://a2:3000/api/proxy/gleaner/games/<game-id>/<version-id>/Computer",
     "definition" : {
        "type" : "https://w3id.org/xapi/seriousgames/activity-types/game-object",
     },
  "result" : {
      "extensions" : {
        "GameDay" : 1.0,
        "GameHour" : "21:30",
        "MobileMessages" : "True"
     }
  },
  "timestamp" : "2018-05-17T12:04:56.835Z"
}
```

Example xAPI-SG tracking

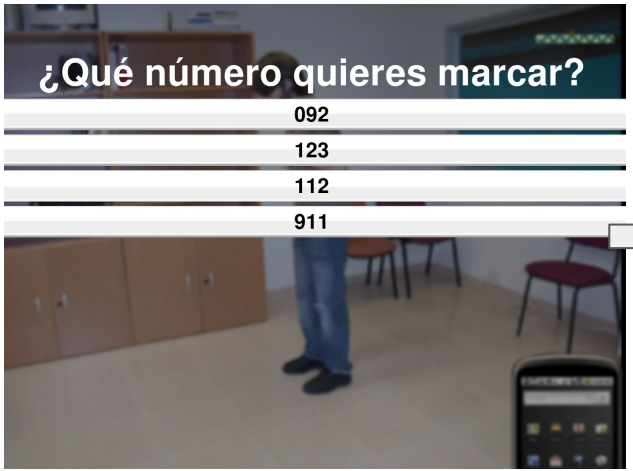
DownTown game to train students with intellectual disabilities how to move around the Madrid Subway.
Example xAPI-SG trace of progressing in a quest.


```
{
  "actor" : {
     "name" : "student1"
  },
  "verb" : {
     "id" : "http://adlnet.gov/expapi/verbs/progressed"
  },
  "object" : {
     "id" : "http://a2:3000/api/proxy/gleaner/games/<game-id>/<version-id>/Mission_1_Ex_ElMaletinMarron",
     "definition" : {
        "type" : "https://w3id.org/xapi/seriousgames/activity-types/quest",
     }
  },
  "result" : {
     "extensions" : {
        "https://w3id.org/xapi/seriousgames/extensions/progress" : 0.3333333
     }
  },
  "timestamp" : "2018-01-08T18:28:36.211Z"
}
```

Example xAPI-SG tracking

First Aid Game to teach first aid maneuvers.

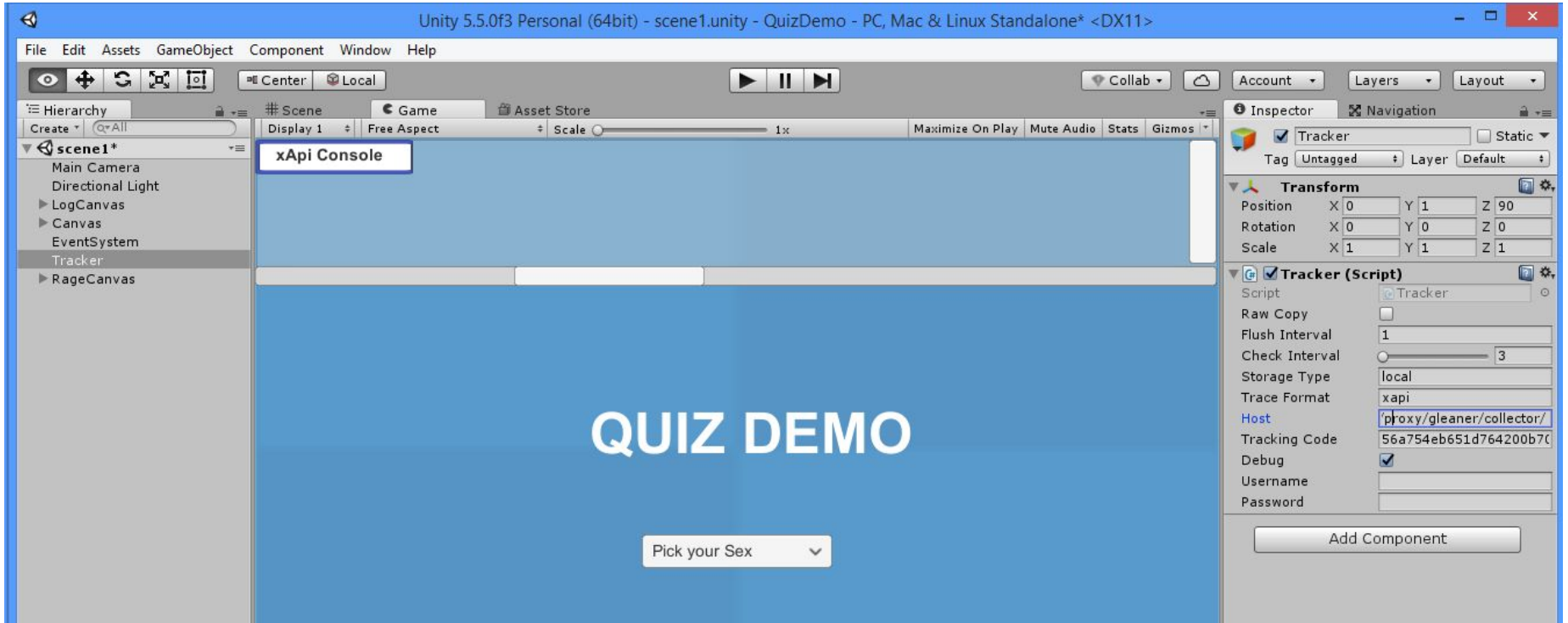
Example xAPI-SG trace of selecting a response in a question.




```
{
  "actor" : {
     "name" : "student1"
  },
  "verb" : {
     "id" : "https://w3id.org/xapi/adb/verbs/selected"
  },
  "object" : {
     "id" : "http://a2:3000/api/proxy/gleaner/games/<game-id>/<version-id>/NumeroEmergencias",
     "definition" : {
        "type" : "http://adlnet.gov/expapi/activities/question",
    }
  },
  "result" : {
      "success" : true,
      "response" : "112"
  },
  "timestamp" : "2017-01-27T03:20:25.571Z"
}
```

Using Unity Tracker: Proof of Concept

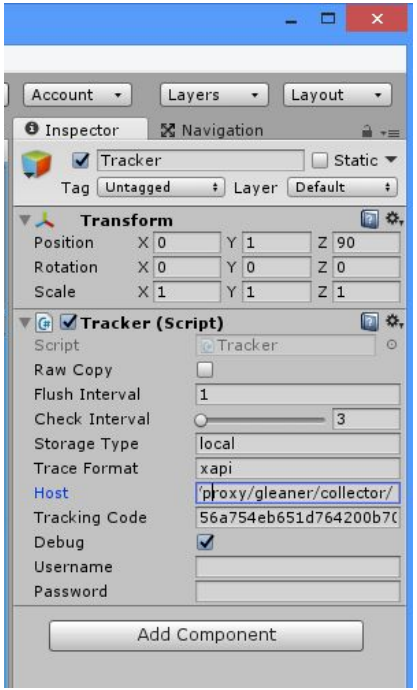
git clone --recursive https://github.com/e-ucm/QuizDemo



Using Unity Tracker: Proof of Concept

Raw Copy: Create a file in the client with all the traces in csv format.
Flush Interval: Time (in seconds) between two shipments of traces.
Storage Type: “local” to only save data into the client or “net” to send data to the server.
Trace Format: How format send the traces (“json”, “xapi” or “csv”).
Tracking Code: Code to match the client to the server and send data to a specific activity.
Debug: Show debug info.
Username and password (optional): anonymous if empty.

Tracker.cs

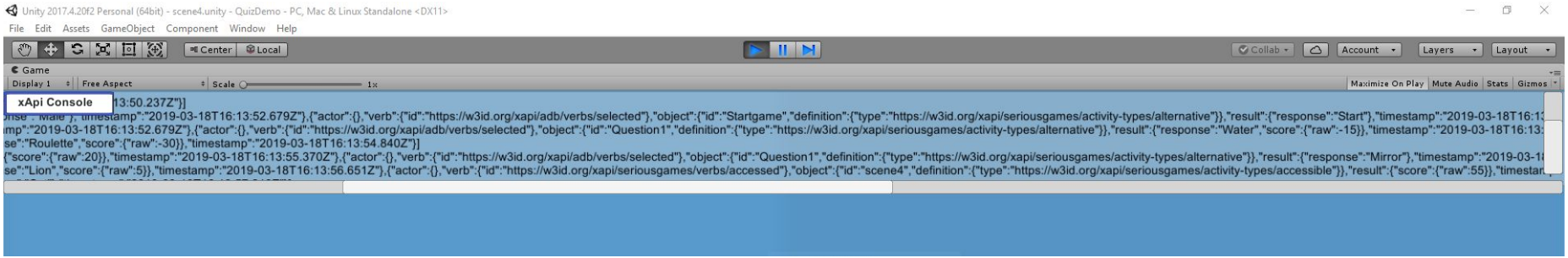


Using Unity Tracker: Proof of Concept

The tracker.cs script is a custom mode to configure TrackerAsset.cs.

The users of tracker can configure their own script to initialize the tracker and to flush the data traces.

→ The “xApi Console” show the sent data.



Using Unity Tracker: Proof of Concept

Sending data (examples):

```
public static TrackerAsset T
{
    get { return TrackerAsset.Instance; }
}
```

```
Tracker.T.Alternative.Selected("Selected sex", sex.text);
Tracker.T.Alternative.Selected("Start game", "Start");
Tracker.T.Accessible.Accessed(sceneName);
SceneManager.LoadScene(sceneName);
```

```
SceneManager.LoadScene(nextScene);
Tracker.T.Accessible.Accessed(nextScene);
```

```
Tracker.T.Alternative.Selected(questionId, optionId);
```

verb: selected
object.definition: alternative
object.id: “Selected sex”
result.response: sex.text

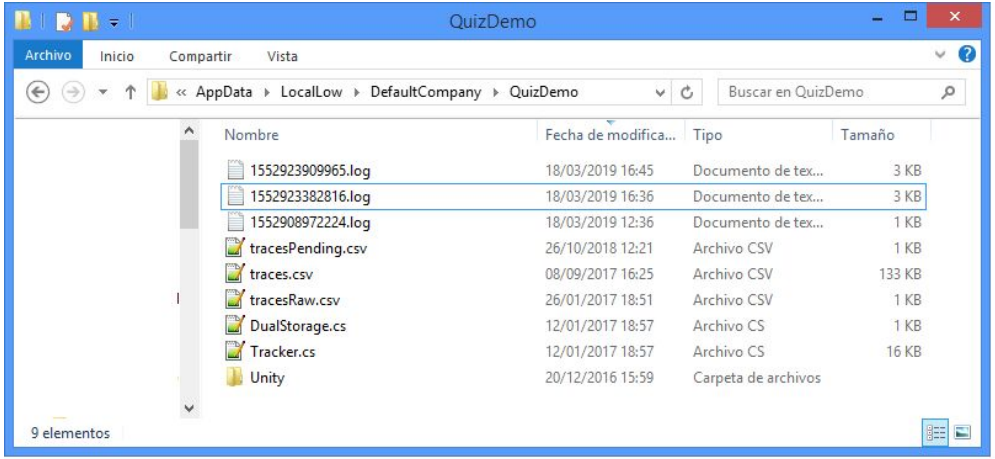
verb: selected
object.definition: alternative
object.id: “Start game”
result.response: “Start”

verb: accessed
object.definition: accessible
object.id: nextScene

verb: selected
object.definition: alternative
object.id: questionId
result.response: optionId

Using Unity Tracker: Proof of Concept

In the QuizDemo case the log and raw data is saved into:
%userprofile%\AppData\LocalLow\DefaultCompany\QuizDemo



References

xAPI-SG Profile:

- Ángel Serrano-Laguna, Iván Martínez-Ortiz, Jason Haag, Damon Regan, Andy Johnson, Baltasar Fernández-Manjón (2017): ***Applying standards to systematize learning analytics in serious games***. Computer Standards & Interfaces 50 (2017) 116–123, http://dx.doi.org/10.1016/j.csi.2016.09.014
- xAPI-SG profile: https://xapi.e-ucm.es/vocab/seriousgames
- GitHub page: https://github.com/e-ucm/rage-analytics/wiki/xAPI-SG-Profile
- ADL Profile page: https://adlnet.gov/news/a-serious-games-profile-for-xapi

Game Learning Analytics:

- Manuel Freire, Ángel Serrano-Laguna, Borja Manero, Iván Martínez-Ortiz, Pablo Moreno-Ger, Baltasar Fernández-Manjón (2016): ***Game Learning Analytics: Learning Analytics for Serious Games***. In Learning, Design, and Technology (pp. 1–29). Cham: Springer International Publishing. http://doi.org/10.1007/978-3-319-17727-4_21-1.

uAdventure:

- https://github.com/e-ucm/uAdventure

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