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Executive Summary

This document, along with D4.1 Report on Learning Outcomes for Gamification, is intended to form an input to the detailed GAP game design process. It investigates the processes and instrumentation required to implement in-game and out-game assessment techniques in order to support post-game data analysis. This document is not intended to detail a final design, rather it is an overview of the player related data factors influencing the GAP game design that will be addressed in the detailed design process in Deliverable 4.4.

Five main areas were investigated:

- 1. The approach to the definition of in-game metrics for player behaviour is described in Section 2. GAP has developed a methodology to identify candidate Behavioural Anchors and Ratings of those behavioural anchors (Behavioural Anchor Ratings Scale). These Behavioural Anchors, combined with other performance metrics collected from the game (such as progress in the game, achievement in the game, decision making, movement, action, and time/speed) will be analysed post-game. Feedback to the player/learner in the game will predominantly be post-game, as part of a reflective interaction or activity. The granularity and specificity of such metrics will be defined as part of the design process of the GAP game.
- 2. Section 3 describes how combining in-game assessment and out-game assessment provides an opportunity to triangulate, i.e., to compare and contrast the self-reporting of attitudes and behaviour of personnel in the out game assessment with their actual behaviour in the immersive game environment. In the GAP evaluation phase, the implementation of the outgame instrumentation will take place with personnel from GAP partners from the following sites: Ireland, Poland, Finland, Portugal and Bulgaria.
- 3. The general format of game events and the design decisions that underlie the format are investigated in Section 4. The format described is intended to be highly extensible, i.e., to allow new event types and event families to be added with minimal or no changes to the existing code. A key factor in the GAP game design will be the granularity of events different game types can generate.
- 4. A proposed element of the GAP game software architecture known as the Game Event Manager is described in Section 5 that allows parameterised game events to be stored by the game engine, such that they can be delivered to external components after the playthrough has finished.
- 5. Finally, as the analysis of in-game metrics lies outside the domain of the game itself a reliable method for communication with a host system performing the analytics must be adopted. Section 6 investigates how evolving eLearning industry standards are beginning to encompass the area of serious games, with the xAPI standard superseding the 1990's era



SCORM standard for eLearning content management. While xAPI is flexible in scope, the key design issues for the GAP game will be determined largely by the granularity of in-game data required as the existing vocabulary of actions defined is of high level actions. The Serious Games Community of Practice, established in mid-2016, is tasked with extending the xAPI vocabulary to capture interactions from game mechanics and we will monitor progress as the GAP game design advances.



1. Introduction

In this document we present an overview of the GAP approach to the instrumentation of the GAP game and collecting player data for post-game analysis. Section 2 describes the approach to in-game behaviour assessment. Section 3 discusses how pre and post-game testing form part of a complete picture of learning activity and attitudes around the GAP game.

In Section 4 an approach to logging in-game player related events in an easy to extend but flexible internal data structure is described. Section 5 then outlines where event capture and logging fit within an overall game architecture.

Section 6 presents an overview of how the dominant eLearning industry standards based approach to collecting and managing eLearning activities has evolved to encompass serious games. Section 7 summarises the design inputs presented in this document.

Annex 1 details the aggregated results of the GAP workshops with outcomes graded according to the BARS (Behaviourally Anchored Rating Scale) rating methodology. Annex 2 provides a presentation used at the GAP workshops describing the process of mapping GAP scenarios to a Competency Framework.



2. In-Game Behaviour Assessment

The GAP In-game assessment will involve a combination of both assessment of behaviours based on Behavioural Anchor Ratings captured during the game as well as analysis of other performance metrics (e.g., decisions, movement, actions, progression within the game, achievements within the game etc.) collected during the game. This assessment will focus upon the key competencies identified for GAP game (e.g. Cultural Awareness, Gender Awareness, Leadership etc.). A key challenge in soft skills assessment is identifying concrete (observable) behaviour which adequately identifies the skills level of a learner. To assist in the in-game assessment (and inform the design of the GAP game), GAP developed a methodology to identify candidate Behavioural Anchors and Ratings of those behavioural anchors (Behavioural Anchor Ratings Scale) which demonstrated key desired peace keeping competencies. A selection of candidate BARS were identified in GAP D3.2 (Learning Outcomes, Skills/Competencies Definitions and Metrics of Assessment).

In order to identify these candidate behaviours for in-game assessment and to inform the design of the game, the GAP Methodology used a combination of workshops involving peace keeping experts drawn from multiple countries and sectors, which extracted ratings of example behaviours of desired competencies which could be used in the design of the GAP game. Figure 2.1 illustrates the overall methodology.

Define critical scenarios (interviews)

Identify GAP competencies within those scenarios

Identify dimensions for each competency Identify examples of behaviours that characterise that dimension Create BARS of these behaviours (Ratings: Outstanding, Competent, Unsatisfactory)

Figure 1 - GAP Methodology (steps 1-5)

In order to check the validity and reliability of the ratings produced from the GAP workshops, the GAP partners are also performing a sixth step in the methodology which involves independent cross-checking of both the behaviours and their ratings with a larger set of subject (Peace Keeping) experts



drawn from multiple countries. The methodology used to identify the BARS is more fully described in GAP D3.2.

Annex 1 of this document provides an aggregated list of the competencies, behaviours and ratings produced at the end of step 5. The reliability and validity checking is currently on-going. Note that during the workshops some behaviours were identified which were considered too high level to be directly observable during the game. These behaviours, although not listed in the annex, have also been used to inform the game.

As the full scenario(s) for the game have not yet been defined, the final selection of the BARS to be used in the game have not yet been finalised and there may be a requirement to define/revise further candidate BARS to fit with or expand the chosen game scenario.

The overall assessment of a player/learner's behaviour within the game will be measured against rated behavioural anchor points observed the game. Feedback to the player/learner in the game will predominantly be post-game, as part of a reflective interaction or activity. This feedback will combine both the results of the BARS analysis as well as other performance metrics collected from the game (such as progress in the game, achievement in the game, decision making, movement, action, time/speed). The granularity and specificity of such metrics will be defined as part of the design process of the GAP game.



3. Out-Game Pre and Post Testing and Integration with In-Game Learning Metrics

3.1 Out-Game Assessment

A selection of GAP's curriculum of CPPB relevant soft skills will be embedded in game scenarios and will be assessed by a suite of methods. These include in-game assessment and out-game assessment as outlined in Deliverable 3.2. This section of this deliverable describes the instrumentation of the learning objectives in the out-game assessment and the integration with in-game learning metrics.

Using games for assessment is about more than tracking points. One of the most common misconceptions is that all good learning games must assess learners within the game. In fact, assessment happens *around a game* as often as it happens *inside the game*, and so we are designing and providing useful assessment tasks pre- and post- game, including qualitative reflection, for training personnel. This offers valuable opportunities to unlock the instructional power of the game and support a student-centered learning environment. Trying too hard to build all of the assessment into gameplay can often destroy the fun factor. Unless the assessment is cohesively integrated into that game's experience students will feel interrupted and might disengage. Hence, GAP also offers assessment through pre and post-game play instruments for measuring competency in the learning objectives, and includes the opportunity for reflection in both.

The use of serious games in the training space is transitioning to "blended learning," i.e., game play and pre and post play student exercises. We aim to bridge the gap between providing innovative spaces for learning and assessing their effectiveness. What both approaches offer, through in-game and out-game assessment, is an explicit commitment to quality assessment that exploits the unique characteristics of these emerging media within the bounds of time-tested constructs such as rigour, validity, and reliability.

Combining in-game assessment and out-game assessment provides an opportunity to triangulate, i.e., to compare and contrast the self-reporting of attitudes and behaviour of personnel in the out game assessment with their actual behaviour in the immersive game environment. The interviews indicate that all personnel are aware of the existence of, and need to comply with, equality regulations within their organization. However, the interviews also indicate that behaviour in the field can deviate from the self-reported approach to e.g. gender and cultural awareness. The combination of assessment offers opportunities to pinpoint behaviours which act as a 'hinge' or key to reflection and change, and to get past the current impasse where the regulations are in place but the experiences in the field demonstrate an institutional persistence of attitudes and behaviours that inhibit effective communication and cooperation with personnel whose organization/nationality/gender/sexuality may be different from one's own identity on these dimensions.



3.2 Pre and Post Game Instruments

The outside of game assessment involves pre-game-playing and post-game playing assessment of one or more of gender awareness, sexualities awareness, cultural competency or awareness, levels of competence in communication, collaboration (cooperation), levels of empathy and trust. We will develop, pilot and revise new instruments for measuring pre/post the defined learning outcomes of gender awareness, cultural competency or awareness, sexualities awareness, levels of competence in communication (cooperation), levels of empathy and trust. We will develop, pilot and revise new instruments for measuring pre/post the defined learning outcomes of gender awareness, cultural competency or awareness, sexualities awareness, levels of competence in communication, collaboration (cooperation), levels of empathy and trust, of students (peacekeeping personnel).

The instruments will be developed through two paths:

- 1. Selecting appropriate items from existing instruments, in the fields of education, health, business and other sector specific measurement scales, and customizing them for use by GAP.
- 2. Drawing attitudinal and behavioural items from the interviews with peacekeeping personnel conducted in WP3, with a specific focus on the behaviours extracted through the BARS methodology described in Deliverable 3.2 and Annex 2 to this deliverable, and benchmarked against international standards as described in Deliverable 6.1.

After game-play, the player takes a post-game playing test on one or more of the same soft skills gender awareness, sexualities awareness, cultural competency or awareness, levels of competence in communication, collaboration (cooperation), levels of empathy and trust, again through instruments customized for use by GAP with items extracted from GAP interviews, in line with the GAP learning objectives and benchmarked against international standards as described in Deliverable 6.1.

Both the pre-game and post-game assessment periods include an option for reflection on the experiences within the game. These instruments, in their itemized measurement and in the reflection parts, and in their timing, provide a means to assess the quality of the experiential learning through role-play.

We will make explicit the key features of the sample, measures, procedures and data-analyses. Although some researchers may use unpiloted survey instruments in their studies, conducting a measurement pilot to establish the reliability and validity of the data of a new instrument in the intended empirical context is considered crucial by most. Internal consistency reliability can be measured by Cronbach's alpha, to establish the precision of our instruments. We will demonstrate the validity of the data of our instruments. We also demonstrate the content validity of our instruments by having experts from the end user partners and Expert Advisory Board review and comment on their content.

Out game assessment also provides the opportunity to triangulate with the in game assessment in GAP – we compare and contrast evidence of their instrument's construct validity and demonstrate



'convergent validity' by examining the estimated correlations between scores on their instrument and scores on the in-game assessment (BARS).

In the GAP evaluation phase, the implementation of the out-game instrumentation will take place with personnel from GAP partners from the following sites: Ireland, Poland, Finland, Portugal and Bulgaria.

3.3 Implementation of the Measures

Each of the four instruments will contain 50-60 item stems and Likert-type response statements which will be randomized and administered to the sample peacekeepers. The personnel will be divided into groups with each assigned to one of the measures of soft skills, e.g., gender awareness/cultural competency, trust/empathy.

- Before the tests are administered, trainers read a prepared statement to all personnel, describing the purposes of the project and how to proceed. Personnel then respond to the 50-60 statements in each instrument before answering a short series of questions that seek demographic data. Personnel work from individual computers, inputting their answers to the questions as they appear on the screen. They are required to answer all questions in a section before moving to the next set.
- 2. The personnel will then be interviewed in an unstructured format for approximately 15 minutes by the researchers.
- 3. Game-play proceeds.
- 4. Post game play, out game assessment again takes place, with a different set of items, also verified for validity and reliability, on the same competency that they took pre-game play.
- 5. Reflection after the game takes place a minimum of 2 hours later in the format of a written statement and in a 15 minute interview with GAP researchers.

The suite of assessment methods offers an opportunity to compare self-assessment in the pre and post-play phase with actual behaviours in the game scenarios as measured in the in-game methodology. This will help identify those behaviours and competencies which individuals think they are proficient at but who do not demonstrate such proficiency in what they do in the immersive digital environment, or vice versa.



4. Event Types for Logging

The game event manager described in Section 5 allows parameterised game events to be stored by the game engine, such that they can be delivered to external components after the play-through has finished. This section defines the general format of game events and the design decisions that underlie the format.

We do not give a full list of event types or parameters, since all but the most basic game events will depend on the game design, which will not be completed until D4.4. In addition, a key factor will be the granularity of events different game types can generate. For instance, a VR game can track a much greater depth of movement information than other non-immersive games.

4.1 Event Format

The general event format is as follows:

(isoTimeStamp, serialNumber, playerId, eventFamilies, eventType, eventParameters)

isoTimeStamp is a string that conforms to <u>ISO 8601</u> (e.g., 2017-08-09T07:47:20Z). This format is industry standard and has the advantage that it is human readable as well as unambiguously machine readable. This value is generated by the Game Event Manager.

serialNumber is an integer that indicates the relative ordering of events in the playthrough. The first event in a given playthrough will have a **serialNumber** of 1. Each successive event will be allocated a **serialNumber** that is one greater than its predecessor. This value is generated by the Game Event Manager.

playerId is a numeric value allocated by the game, which identifies a particular player. The game will likely implement some sort of authentication mechanism where a player logs in, for example using a username and password. During this process, the **playerId** is either created (if it is a new player) or retrieved (if the player has played the game before). **PlayerId** may also be defined earlier during the pre-game testing phase.

eventFamilies is a list of strings, each of which indicates a group of events to which this event belongs, for example "motorics," which would have to do with player movement; "admin," which would have to do with player and/or game management or "decision," which would be used to group events related to discrete player decisions, e.g., in relation to a branching narrative. The examples given here are tentative, and the exact groups suitable for the game will be defined by the game designers as part of the design and implementation of the game itself. An event may belong to multiple families at the same time in which case its value for **eventFamilies** has a length greater than 1.



eventType is a string denoting the exact type of event in question. An example might be a "playerMovement" event or a "narrativeBranchTaken" event. Note that the types are given as strings and the event system is not strongly typed.

eventParameters is an object containing details about the event in question. The object's format (attribute names and types) will vary between different event types, but the same events of the same type should have **eventParameter** objects that have identical attribute names and types. As noted above, this is a requirement that isn't enforced since events are not strongly typed.

Events can be represented in different fashions for export and interchange, such as JSON, XML, etc. Alternatively, an API based reporting approach can alleviate some of the development overhead and offer a robust model for deployment, as explored in Section 6. Below are some examples of what events could look like in JSON and XML formats:

Possible JSON representation of playerMovement event:

```
{
  "isoTimeStamp": "2017-08-09T07:47:20Z",
  "playerId": 42,
  "eventFamilies": ["motorics"],
  "eventType": "playerMovement",
  "eventParameters": {
    "location": {
       "x": 0.0,
       "y": 0.0,
      "z": 0.0
    },
    "orientation": {
       "x": 0.0,
       "y": 0.0,
       "z": 0.0
    }
  }
}
```



Possible XML representation of playerMovement event:

```
<?xml version="1.0" encoding="UTF-8" ?>
<root>
  <isoTimeStamp>2017-08-09T07:47:20Z</isoTimeStamp>
  <playerId>42</playerId>
  <eventFamilies>motorics</eventFamilies>
  <eventType>playerMovement</eventType>
  <eventParameters>
    <location>
      <x>0</x>
      <y>0</y>
      <z>0</z>
    </location>
    <orientation>
      <x>0</x>
      <y>0</y>
      <z>0</z>
    </orientation>
  </eventParameters>
</root>
```

4.2 Event Families

Each event belongs to one or more event families, which essentially work like tags. The game component that logs an event is responsible for choosing which event families to attach the event to. The intention of event families is to allow events to be grouped logically, not in a static hierarchical fashion, but in a dynamic fashion that depends more on what the event *means* (or is likely to mean) in the context of the playthrough. The intention is to facilitate selective export of different sets of events post play.

Examples of possible event families include:

- Motorics (player movement)
- Decisions (player making discrete choices in narrative terms)
- Administration (game begin, end, save, load, pause)
- Competency (an event that has to do with learning objectives)
- CompetencyGender (a learning objectives event, specifically in relation to gender awareness)
- CompetencyCulture (similar to above, but for general cultural awareness)
- (...)



4.3 Specific Event Types

The game is expected to have a considerable number of event types. Below is a list of possible event types. The design phase (WP4.4) will determine which specific event types are suitable.

Event Type	Event Parameters	
BeginGame	playerId, difficultyLevel	
EndGame	(none)	
PlayerMovement	newOrientation, newLocation	
()	()	

4.4 Future Extensions

The format described here is intended to be highly extensible, i.e., to allow new event types and event families to be added with minimal or no changes to the existing code. For example, because events are weakly typed and event types and event families are simply strings, adding a new event or event family will be possible without any changes to the game engine in general or even the game event manager.



5. Technical Outline of In-Game Analytics Component (Game Event Manager)

This section presents a high-level view of an in-game analytics component called the Game Event Manager (GEM). The purpose of this component is to collect and store game event data of pertinence to (but not limited to) the game's Learning Objectives.

The purpose of the Game Event Manager is to allow other game components to register and store game events, such that they can be recorded for later analysis. It also allows the event log for a completed game to be delivered for analysis to external components in a standardised format.

5.1 Architecture Diagram

The overall architecture of the Game Event Manager is given in Figure 1. The GAP game engine will consist of a series of components, each of which is responsible for a specific category of game functionality. The exact responsibilities of the components need to be defined, but examples could include a Narrative Component responsible for narrative structure and branch selection, a Character Behaviour Component responsible for driving individual character behaviour and animations, and in a fully immersive game a Spatial Audio Component responsible for creating the soundscape in the game scenarios.

Some (but not all) of these components are expected to use the Game Event Manager as shown in the figure. Note that the Assessment Component is external and is invoked across a machine boundary. This happens after the play through in order to transfer the play log to the assessment component, such that the player's performance can be measured.

The Game Event Manager itself consists of a relatively small number of components. The Logging Component offers a simple API (discussed in section 4.2) to let the other game engine components log events. The Logging Component works as a sequencer, attaching serial numbers and timestamps to the events it receives and saving them to the Storage Component. The different Export Components allow the saved events to be exported in different formats, depending on what is required. They are described in more detail in section 5.3.

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Figure 2 - Game Event Manager. Boxes denote software components, arrows denote invocations.

5.2 API

The API to the Game Event Manager is simple, consisting of a single intra-engine method:

boolean raiseEvent(integer playerId, string eventType, object eventParameters, list eventFamilies)

The types are as given in section 3.1 above, i.e., **playerId** is an integer, **eventType** is a string, **eventParameters** is an object, and **eventFamilies** is a list of strings. The method returns **true** on success and **false** on failure.

5.3 Export Components

Initially, we expect Export Components for JSON and/or XML to be created depending on the requirements from the Assessment Component, but others could be added easily later on, such as direct API support for an eLearning framework.



We are not expecting the Export Components to offer specific query or search functionality at this point, but rather that they be written to export the specific subset of the events logged, as required, to the Assessment Component. Assuming that the Assessment Component is able to function synchronously, the relevant exporter(s) will be triggered in response to a GameEnd event, causing the relevant log entries to be transferred to the Assessment Component and a response to be returned to the game engine, such that it can be conveyed to the player post-play but without further delay. Alternatively, the Assessment Component may be operating asynchronously and log entries will be uploaded post-game.

5.4 Implementation Considerations

During play, performance of the Logging Component will be highest priority because it is invoked with real-time constraints. The performance of the Export Components will be secondary, since they will be invoked post-play where real-time constraints are not crucial.

A balance will need to be struck between the bandwidth required to save the event data to disk and retaining it in memory. Most likely, the Logging Component will need to accumulate a certain number of events (effectively, the size of an event buffer) which when full will be handed off to another thread, which will save the data asynchronously to an event log on a local disk where it is stored persistently. The buffered event data will also be saved in case the game is completed, crashes, is paused or its explicit "save game" function is invoked (in case the game will have such a function).

There is a privacy concern since the on-disk event log contains sensitive (performance related) data. For performance reasons, we do not expect that the locally stored event log will be encrypted in real time, but rather that it upon one of the above mentioned game events (e.g., game completion, game crash) will be transmitted in a secure fashion to a remote server (operated by one of the project partners) where it will be stored in an encrypted fashion. Following this transfer, the on-disk event log will be deleted from the game client.



6. Output Formats for Post-Game Analytics

As the GAP game offers the potential for deep analytic information to be collected, a framework to support the capture, collection, and analysis of in-game metrics is required. Secondly, the analysis of in-game metrics lies outside the domain of the game itself and therefore a reliable method for communication with the host system performing the analytics must be adopted.

The eLearning industry faced this challenge early on as early adopters of online training needed to collect information from online course content modules delivered as self-contained web pages. In addition, there was a pressing need for standardisation of content definitions so that content could be reused on different Learning Management Systems (LMS).

The answer came in the form of the SCORM reference model developed in 1999 following direct intervention by President Bill Clinton with the US Department of Defence and Advanced Distributed Learning. SCORM includes a basic reporting method based on an small embedded JavaScript API that allowed a small vocabulary of events to be communicated back to the host LMS.

6.1 SCORM

SCORM or the Shareable Content Object Reference Model is focussed on the sharing and reuse of eLearning content. SCORM is composed of three sub-specifications:

- The Content Packaging section, based mainly on XML, is concerned with how the eLearning content objects are packaged and described.
- The Run Time section details how content should be invoked and how it communicates with the host LMS. It is based primarily on ECMAScript (JavaScript).
- The Sequencing section deals with navigation between parts of the course (SCOs). It is defined by a set of rules and attributes written in XML.

The Run Time specification is the most relevant section of SCORM to the GAP game.

The run-time specification states that the LMS should launch content in a web browser, either in a new window or in a frameset. The LMS may only launch one SCO at a time. All content *must be web deliverable* and it is always launched in a web browser. This is a limitation in the context of GAP, as it places constraints on the game types that could be created.

Once the content is launched, it uses a JavaScript API that is provided by the LMS and has functions that permit the exchange of data with the LMS. The CMI data model provides a list of data elements (a vocabulary) that can be written to and read from the LMS.

Some example data model elements include the status of the SCO (completed, passed, failed, etc), the score the learner achieved, a bookmark to track the learner's location, and the total amount of time the learner spent in the SCO.



The API (as of SCORM 2004) supports the following commands to implement communication with the LMS:

Initialize("") : bool Terminate("") : bool GetValue(element : CMIElement) : string SetValue(element : CMIElement, value : string) : string Commit("") : bool GetLastError() : CMIErrorCode GetErrorString(errorCode : CMIErrorCode) : string GetDiagnostic(errocCode : CMIErrorCode) : string

The SCORM model is primarily concerned with events at the boundary of SCO's, rather than detail of activity while the SCO is being accessed. Over time, the eLearning world expanded beyond web centric delivery with a realisation that learning activity should be considered in a wider context, for instance the learning taken from a web search on the topic being taught, should be considered and if possible tracked so that it can be analysed as part of the overall learning experience. As GAP is developing a potentially rich source of in-game information the SCORM Runtime API is limited in scope.

6.2 xAPI

2010 saw the xAPI (also known as Experience API or Tin Can API) emerge after Advanced Distributed Learning (ADL) sought input on the development of the next generation of SCORM. xAPI allows for a broad vocabulary of event types and even recognized the new development of serious games as eLearning content. Version 1.0 of xAPI was launched in 2015 and it is seen as the logical successor to the SCORM reference model.

The GAP game will be capable of collecting information relating to the player's progress within the narrative structure of the game, together with events that can potentially yield insights into the player's behaviour in the game, as described in Section 4.

xAPI is a web-based service that allows compliant systems to pass information, in the form of statements, to a Learning Record Store (LRS). The LRS can either be a stand-alone system or may be integrated into a Learning Management System. xAPI comprises a set of functions and procedures for capturing data in a standard format about a learner's activities. Data is captured in the form of "statements".

Statements consists of 3 elements in the format of [Actor][Verb][Object]:

- Actor (it's the noun, or the person who performs an action)
- Verb (it's the action that was performed)
- Object (it's the "where" or the "what" part of action)

Statements are formatted like this:



```
{
    "Actor": {
        "Actor": {
        "Name": playerID,
},
    "Verb": {
        "Id": "<u>http://adlnet.gov/exapi/verbs/completed</u>",
        "Id": "<u>http://adlnet.gov/exapi/verbs/completed</u>",
        "Display": { "en-US": "completed" }
    {,
        "Object": {
        "Id": "<u>http://hauntedplanet.com/gapgame</u>",
        "Definition": {
            "Name": { "en-US" "GAP Training Game" }
        }
    }
}
```

Extending the "Actor – Verb – Object" structure, a lot more information can be included in a statement, for example:

- A Result statement: [Mary] [attempted] [GAP_Scenario_1] [with score 600]
- A Contextual statement: [Samantha] [completed] [GAP_Scenario_4] [in the context of Cultural Awareness]

xAPI has a vocabulary of verbs like completed, attempted, scored, resumed, read, attended, commented, registered, responded, failed, and so on. It uses these statements to track user activities and saves them to a Learning Record Store. A system that is xAPI compliant is known as an "Activity Provider". The LRS repository can then be accessed by an LMS (Learning Management System) or a stand-alone post-game analytics platform.

xAPI allows developers to define a local vocabulary of verbs and activity types known as a "xAPI Profile". This feature may enable the mapping of the instrumentation described in Section 3 to xAPI statements for uploading to an LRS for post-game analytics, if xAPI is the preferred reporting mechanism. There is also the potential for using xAPI to facilitate the integration of pre, post, and ingame analytic information.

Finally, as xAPI recognises serious games as a learning opportunity, ADL have formed a Serious Games Community of Practice. Established in mid-2016, it is tasked with extending the xAPI vocabulary to capture interactions from game mechanics.



7. Conclusion

In this document, an overview of the GAP approach to capturing player related data has been presented.

In Section 2, we saw an overview of the GAP approach to in-game behaviour assessment, with Annex 1 of this document providing an aggregated list of the competencies, behaviours and ratings produced by the five step GAP Methodology described in Section 2.

Section 3 discussed the structure of pre and post-game testing using customised instruments, providing insight into player attitudes before playing the game and following reflection post-game.

Section 4 describes how in-game player related events can be grouped into Event Families as part of a Game Event Manager, in an easily extended structure that supports collection of data during the GAP game, and upload to an analytic service at the end of the game.

A proposed architecture for the in-game instrumentation was described in Section 5. Together with the discussion in Section 6 of how the xAPI specification is superseding SCORM as the eLearning industry standard for management and analysis of learning experience data. Multiple options for collecting and reporting in-game player data are shown to be possible.

Design decisions regarding the method chosen will be influenced by the granularity of the data possible in the chosen game type and the impact of such data collection on the game experience/game's performance.



Annex 1

Aggregated results from GAP Workshops to create BARS based on authentic scenarios

The GAP team has held 3 workshops (Dublin, Helsinki, Warsaw). The workshops followed the methodology as suggested by Spangenberg et al., (1989) to construct BARS in order to support assessment of soft skills competencies in the GAP game, using authentic scenarios that were created based on a series of interviews. Approximately 30 Subject Matter Experts (a mix of military, civilian, and police peacekeepers) provided their input, following the methodology as illustrated in Figure 1 below. The final (sixth) step focuses on validation and verification of the generated Behaviour Anchors' Ratings.

Define critical scenarios (interviews) Identify GAP competencies within those scenarios

Identify dimensions for each competency Identify examples of behaviours that characterise that dimension

Create BARS of these behaviours (ranking 1-3 initially)

Figure 1. Workflow of GAP Methodology



The workshop participants picked out important incidents, decisions or events in the scenario & vignette which they believed showed behaviours at the identified dimensions or at which they could suggest alternative behaviours illustrating those dimensions.





Scenario 1 - Vignette #1 (The Mob)

Incident: Before going to the apartment building were Serbs live

Competency	Dimension	Behaviour	Rating
Cooperation	Planning/Organising	Consult with colleagues	[Competent]
		Not consulting colleagues	[Unsatisfactory]
Communication	Clarity (making sure)	No statement on plan/Taking for granted that colleagues know the plan	[Unsatisfactory]
		Explicitly stating the plan, and sequence of planning	[Competent]
		Checking they understand by soliciting feedback	[Outstanding]
Leadership	Planning/organising	Taking into account where you're going, what to bring, what interpreter to bring, how many cars, where to park them etc.	[Competent]

Incident: Taking the Serb family under protection.

Competency	Dimension	Behaviour	Rating
Leadership	Decision Making	Asking for their guns	[Competent]
		Putting family under guard	[Competent]
		Secure perimeter of apartment block	[Competent]
		Allowing them to refuse to hand over the firm arms	[Unsatisfactory]



Incident: Communicate with colleagues during the incident

Competency	Dimension	Behaviour	Rating
Cooperation	Cooperation	Cooperation with colleagues during the incident.	
		Getting interpreter to do more than translate – get ideas from them	[Competent]
		Give jobs to almost everybody	[Outstanding]
		Give job to police officer to keep Serbs busy ['Could you help me? I need your help']	[Outstanding]

Incident: Communicating with Serb families during the incident

Competency	Dimension	Behaviour	Rating
Cooperation	Commuication	Give tasks to help calm down and focus	[Outstanding]
		Ignoring the stress of Serbs	[Unsatisfactory]
		Say everything will be OK	[Competent]
Leadership	Communication	(showing fear) Shouting at team & families – indicating that negative or unsureness	[Unsatisfactory]
		Briefing family/colleague and keeping them informed	[Competent]
		Action oriented + reassuring family/colleagues	[Outstanding]



Incident: Decision to stay & protect the Serbian families when African soldiers got orders to leave and fled leaving flak jackets & helmets.

Competency	Dimension	Behaviour	Rating
Leadership Decision Makin		Staying but sending briefing asking for backup	[Competent]
		Leaving with Africans	[Unsatisfactory]
		Staying but sending briefing asking for backup at same time as communicating with Family & Mob	[Outstanding]
		Leaving two police to mind vehicles	[Unsatisfactory]

Incident: After Africans military left building, decision to deal with situation.

Competency	Dimension	Behaviour	Rating
Leadership	Decision Making	Send interpreter (Serbian) out on her own to talk to mob (probably would be killed)	[Unsatisfactory]
		Go out with interpreter (Serbian) and protect her and try and communication with crowd	[Competent]
		Go out with her (= interpreter), identify leaders and communicate with leader via interpreter	[Outstanding]
	Cultural competency	Select interpreters – BOTH Albanian and Serb	[Outstanding]
		Select Albanian speaking Serb	[Competent]
		Select Serb who speaks	
	Toom	Albanian Danickod shouting ("Mo'ro	[Unsatisfactory]
	communication	fucked!", "How will we get out of here?, "Where's my	ເບົາເຈັດເຮັກສິດເບົາ y



	Planning/organising	backup?") Briefing colleagues and civilians, information passive Reassure, build confidence, tell what we're doing next, action oriented, specific steps to get out of the situation Not asking for police backup Ask for back up through the radio Advice police chiefs to get military backup as well as police backup	[Competent] [Outstanding] [Unsatisfactory] [Competent] [Outstanding]
Communication	Culturally appropriate interpretation	Police repeat what Serbian interpreter says in Albanian (male voice and local dialect) Ask for spokesperson from group according to language to create bridge Not communicating at all Aggressive communication – shouting 'stop!' and raising guns Letting interpreter speak in Serbian	[Outstanding] [Outstanding] [Unsatisfactory] [Unsatisfactory] [Unsatisfactory]
	Decision Making (Calming / de- escalation)	Ask for suitable spokesperson Telling mob 'stop! Call for backup immediately Calling for backup not immediately but once you realize the gravity of the situation	[Outstanding] [Unsatisfactory] [Outstanding] [Competent]



	Not asking for backup/panicking	
		[Unsatisfactory]
Understanding what the mob	Say stop	[Unsatisfactory]
wants/ Showing empathy	To shoot	[Unsatisfactory]
	Ask the spokesperson what you need to the mob	[Outstanding]
	Ask for spokesperson from group according to language to create bridge	[Outstanding]
Timeliness	Ask for backup immediately	[Outstanding]
	Ask for backup in midst of situation	[Competent]
		[Unsatisfactory]
Motivation	Positive feedback/praise	[Outstanding]
	Acknowledgement of good job	[Competent]
	Criticism or no comments	[Unsatisfactory]

Incident: Deploying 2 Military to look after the 2 vehicles.

Competency	Dimension	Behaviour	Rating
Leadership	Decision Making	Leave two police to mind vehicles	[Unsatisfactory]
		Bringing in the two police officers (rather than leaving them outside and splitting the protection force)	[Competent]



Scenario 2 - Vignette #2 (Trepca Mine)

Incident: In preparation for operation at Trepca Mine

Competency	Dimension	Behaviour	Rating
COOPERATION	Sharing intelligence	Not having common meetings	[Unsatisfactory],
		Formal common meetings	[Competent]
		Exchanging information in meetings and outside meetings (formally and informally)	[Outstanding]

Incident: Working with other national units on joint operation at the mine

Competency	Dimension	Behaviour	Rating
COOPERATION	Making common plans	Requesting but not confirming	[Unsatisfactory]
		Requesting and getting confirmation	[Competent]
		Requesting and preparing joint implantation of plans	[Outstanding]
	Across organisational boundaries	Not showing up	[Unsatisfactory]
		Showing up	[Competent]
		Show up but refuse to do anything	[Unsatisfactory]
		Showing up and acting	
		in unison	[Outstanding]
	Commuication	Recognise key personnel	[Competent]



		Mediate	[Competent]
		Express your own goals	[Competent]
		Know your own mission and mandates	[Outstanding]
		Lose temper or use of force	[Unsatisfactory]
Building Trust	Homework (planning and organising before and during the mission or operation)	Showing limited or no consideration for the situational framework	[Unsatisfactory]
		Emphasizes the willingness to cooperation	[Competent]
		Showing personal interest and respect	[Outstanding]
Creativity	Contacting and identifying counterparts and local leaders	Establishing contact with prominent contacts	[Competent]
		Identify "real" leaders and persons of authority	[Outstanding]
		Being passive	[Unsatisfactory]

Incident: Following the operation

Competency	Dimension	Behaviour	Rating
Cooperation	Ensuring institutional memory	Passing on written up reports	[Competent]
		Passing on reports and tacit information and contacts	[Outstanding]
		No transfer of written or verbal experience	[Unsatisfactory]
Communication	Listening	Enhanced feedback – asking for and receiving colleagues	[Outstanding]



	thoughts/opinions on the matter at hand Feedback – asking for and receiving	[Competent]
	confirmation that colleague has understood you No feedback	
		[Unsatisfactory]
Clarity	Using Jargon	[Unsatisfactory]
	No org jargon	[Competent]



Scenario 2 - Vignette #1 (Cigarettes)

Competency	Dimensions	Behaviours	Ranking
CULTURAL	Acceptance of	Don't comment and	[Competent]
AWARENESS	customs around	accept	
	gender relations/roles		
		Express disapproval/or	[Unsatisfactory]
		discomfort	
		Convoline anting an a	
		strange/offending babit	[] Insatisfactory]
		expressing approval	
	Food etiquette	Accept food no matter	[Competent]
		what	
		Accept with happiness	
		Defuse neint blenk	[Outstanding]
		Refuse point blank	[] Insatisfactory]
		Rrefuse with excuses	
			[Competent]
	Interactional	Following/mirroring	[Competent]
	etiquette	behaviour of host	
			ful e e d'afa e e e l
		Insisting on doing things	[Unsatisfactory]
		contradicts local custom	
		(e.g. keeping your shoes	
		on)	
		Initiating appropriate	[Outstanding]
		local etiquette	
	Communication	Creal talls Family Creat	[Outstanding]
	Communication –	Small talk, Family , Sport	[Outstanding]
	appropriate Topics of	Polite listening	
talk		[Competent]	
		No small talk/straight to	
		business	[Unsatisfactory]
	Timing of Talk	NO business talk during	[Competent]
		Business talk over	[Competent/outstanding]



		coffee or drinks	
		Talking too much and all the time	[Unsatisfactory]
Cooperation	Team work/Collaboration	Using experience of colleagues	[Outstanding]
		Ignoring experience of colleagues	[Unsatisfactory]
		Too focused on own ends, not taking into account impact on colleagues	[Unsatisfactory]
		Formal cooperation	[Competent]
		Actively assisting colleague in their goals	[Outstanding]



Annex 2

Mapping GAP Scenarios to a Competency Framework to Enable Assessment in the Game

Project number: 700670 Project Acronym: GAP D 4.2 Report on Learning Metrics and Recommended Instrumentation







Mapping GAP Scenarios to a Competency Framework to Enable Assessment in the Game

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INTRODUCTION





GAP Goals

- Identify current gaps in training soft skills in relation to building.
- Develop an innovative base curriculum, including an online soft skills and to provide an immersive learning





The Context of the Game







Possible User Experience







Key Challenge in Designing the GAP Game

We need a connection from the identification of **key GAP competencies** from the scenarios (harvested through interviews) to **assessable behaviours** of users/learners **in the game**.





Some Definitions

Skills	The ability to access knowledge from a domain-specific knowledge base and use that knowledge to perform an action or carry out a task.
Competency	A combination of knowledge, skills and attitudes <i>applied</i> appropriately to a context in order to achieve a desired outcome (OJEU 2006). In other words, the knowledge, skill and attitude is being considered as a behaviour (i.e. it combines the use of knowledge, skill and attitude) within a context.
Dimension	A characteristic of a competency which is required to be evaluated.
Behaviourally Anchored Rating Scale (BARS)	A specific example of actions related to a dimension. Illustrates a 'proficiency level of behaviour; that is an anchor defines what being really strong or weak in a certain behaviour looks like.



High Level Process



* Examples of excellent, average, and poor behaviour





This is what we will focus on today

Define GAP competencies within those scenarios

Identify dimensions for each competency Identify examples of behaviours that characterise that dimension





The Competency Framework





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LET'S GET STARTED





Workshop Objectives and Outcome

By the end of this workshop, you will have executed the GAP methodology for defining competencies, dimensions, and behaviours to be used in the game, through:

- Analysing scenarios to identify key competencies and dimensions.
- o Identifying behaviours and their ratings.
- Identifying which dimensions or behaviours should be included based on assessibility in a game.

OUTCOME:

You will have developed a list of competencies based on the scenarios and have mapped them to dimensions, game-assessable behaviours.



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STEP 1: Create a set of competency dimensior with associated behaviour examples depicting excellent, average and poor performance.





Methodology - Step 1

- a. Identify potential competencies in the scenario.
- b. Identify dimensions of a competency e.g. for the competency Communication, dimensions could include Listening, Non Verbal and Clarity.
- c. Elicit critical examples of behaviour for each of the identified dimensions.
- d. Indicate excellent, average and poor rating for each behaviour identified.





Methodology - Step 1a

- a. Identify potential competencies in the scenario.
- b. Identify dimensions of Competency e.g. Listening, Non verbal and Clarity Communication Skills.
- c. Elicit critical examples of behaviour for each of the identified dimensions.

Indicate excellent, average and poor rating for each behaviour identified.



Example



The standards there were definitely, you know, mixed, mixed enough standards... but, ya! And I suppose I had 3 weeks on out-post and it actually got kind of miserable. It rained at one stage and the place just turned, cos it's all quite dusty over there, so it just turned into total muck but ah, this was my first 3 weeks. The only thing we really, there was kind of packs of dogs that were trying to get in and get food from the post cos the Fijians had, rather than disposing of the rubbish, they had this big pit that they used to burn it in and the dogs used to try and come in to eat from that.

Page 5, last paragraph

Problem-solving?

Leadership?

Communication?

Collaboration?





Activity 1A: Identify Potential Competencies in the Scenario

	Activity Flow	Individually/	Time
		(Sub) group	
1A.1	Identify potential competencies based on	Individual	5 mins
	the vignette		
1A.2	Discuss as a group	Group	5 mins





Recap









Methodology - Step 1b

- a. Identify potential competencies in the scenario.
- b. Identify dimensions of Competency e.g. Listening, Non verbal and Clarity Communication Skills.
- c. Elicit critical examples of behaviour for each of the identified dimensions.

Indicate excellent, average and poor rating for each behaviour identified.



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The standards there were definitely, you know, mixed, mixed enough standards... but, ya! And I suppose I had 3 weeks on out-post and it actually got kind of miserable. It rained at one stage and the place just turned, cos it's all quite dusty over there, so it just turned into total muck but ah, this was my first 3 weeks. The only thing we really, there was kind of packs of dogs that were trying to get in and get food from the post cos the Fijians had, rather than disposing of the rubbish, they had this big pit that they used

(Collaborative) Problemsolving:

- 1. Problem-analysis
- 2. Problem definition
- Generate candidate solutions
- 4. Evaluate (pros/cons)
- 5. Decision-making
- 6. Reasoning
- Leadership
- 8. Communication

With all this comes into play: experience, prior knowledge, beliefs







Activity 1B: Identify Dimensions for One Competency

	Activity Flow	Individually/ (Sub) group	Time
1B.1	Identify dimensions for one competency	Sub-group	5 mins
	based on the vignette		
1B.2	Discuss and agree with group	Group	5 mins





Recap









Methodology - Step 1c

- a. Identify potential competencies in the scenario.
- b. Identify dimensions of Competency e.g. Listening, Non verbal and Clarity Communication Skills.
- c. Elicit critical examples of behaviour for each of the identified dimensions.

Indicate outstanding, competent and unsatisfactory rating for each behaviour identified.



Example



Competency

 Collaborative Problemsolving

Dimensions

- Problem-analysis
- Problem definition
- Generate candidate
- solutions
- Evaluate (pros/cons)
- Leadership
- Communication
- Decision-making

Behaviour examples:

- Focuses on the symptom instead of the problem
- Considers other people's perspectives
- Encourages suggestions and contributions from team
- Pre decides appropriate solution
- Uses a structured approach to assess candidate solutions
- Summarises strengths and weaknesses of candidate solutions proposed by team





Example



Behaviour examples:

- Focuses on the symptom instead of the problem unsatisfactory
- Considers other people's perspectives competent
- Encourages suggestions and contributions from teamoutstanding
- Pre decides appropriate solution unsatisfactory
- Uses a structured approach to assess candidate solutions outstanding
- Summarises strengths and weaknesses of candidate solutions proposed by team- competent





Activity 1C: Identify Behaviours and Rate Them

	Activity Flow	Individually/	Time
		(Sub) group	
1C.1	Identify critical examples for your	Sub-group	15
	dimension and rate them as being		mins
	outstanding, competent, or unsatisfactory		
	Make sure the behaviours are distinct,		
	solid, and observable.		
1C.2	Discuss and agree with group	Group	10
			mins





Recap









What We Have Now

Output 1.

A set of dimensions with associated behaviour examples depicting unsatisfactory, competent, or outstanding performance.





REPEAT FOR OTHER VIGNETTES IN BOTH SCENARIO 1 & 2.



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STEP 2: Select, Consolidate & Retranslate the Dimensions & Ratings





Methodology - Step 2

- a. Remove redundancy from overlapping dimensions (identified in step 1) and produce meaningful constructs for the resultant dimension.
- b. 'Reword' behaviour examples elicited during brainstorming session to the newly defined dimensions. Categorise examples behaviors as unsatisfactory, competent, or outstanding (as indicated in step 1).

Filter out (exclude) those dimensions & associated behaviors which are not representable/automatically observable within the game context





Methodology - Step 2

- a. Remove redundancy from overlapping dimensions (identified in step 1) and produce meaningful constructs for the resultant dimension.
- b. 'Reword' behaviour examples elicited during brainstorming session to the newly defined dimensions. Categorise examples behaviors as high, average or low (as indicated in step 1)

Filter out (exclude) those dimensions & associated behaviors which are not representable/automatically observable within the game context





Activity 2A: Remove redundancy from overlapping dimensions & produce meaningful constructs for the resultant dimension

	Activity Flow	Individually	Time
		/(Sub)	
		group	
2A.1	Identify overlapping dimensions – remove	Group	5 mins
	redundancy		
2A.2	Produce meaningful constructs for the	Group	5 mins
	resulting dimension		





Methodology - Step 2

- a. Remove redundancy from overlapping dimensions (identified in step 1) and produce meaningful constructs for the resultant dimension.
- b. 'Reword' behaviour examples elicited during brainstorming session to the newly defined dimensions. Categorise examples behaviors as high, average or low (as indicated in step 1)

Filter out (exclude) those dimensions & associated behaviors which are not representable/automatically observable within the game context





Activity 2B: 'Re-translate' behaviour examples to the newly defined dimensions and rate behaviours

	Activity Flow	Individually/ (Sub) group	Time
2B.1	Reword the behaviour examples for the	Group	10
	newly defined dimension		
2B.2	Vote if assessable through game or not	Group	5





What We Have Now

Output 2.

Consolidated tables with a final dimension, final examples of behaviours, and rating of the behaviours; to be INCLUDED in the game.







- (i) Train other SMEs in methodology
- (ii) Test out artefacts produced

(iii) Gain insight into level of effort required




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