Generating Education in-Game Data: The Case of an Ancient Theatre Serious Game

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Abstract: Learning Analytics have become an indispensable element of education, as digital mediums are increasingly used within formal and informal education. Integrating specifications for learning analytics in non-traditional educational mediums, such as serious games, has not yet reached the level of development necessary to fulfil their potential. Though much research has been conducted on the issue of managing and extracting value from learning analytics, the importance of specifications, methods and decisions for the initial creation of such data has been somewhat overlooked. To this end, we have developed a custom library that implements the Experience API specification within the Unity 3D game engine. In this paper, we present this library, as well as a representative scenario illustrating the procedure of generating and recording data. Through this work we aim to expand the reach of learning analytics into serious games, facilitate the generation of such data in commercially popular development tools and identify significant events, with educational value, to be recorded.

1 INTRODUCTION

The rapid growth of ICT during the past decades and the resulting significant lifestyle changes have not left education and learning unchanged. Students, in our digital age have developed different thought processes, compared to students of the past that did not use digital mediums, and thus education has to transform in order to adapt (Prensky, 2001). Additionally, this development and integration of ICTs in our lives has also raised new demands in education (Kalogiannakis and Papadakis, 2007; Kalogiannakis, 2008). Ongoing research in the field, aims to create innovations that will address students' current and future needs (Livingstone, 2012). As a result, a number of digital tools, devices and platforms are now available to education professionals. They can therefore rethink and reshape educational and assessment practices, methods and environments to be the best fit for their students, with less ties to traditional teaching and grading methods and practices (McFarlane et al., 2002). Such digital resources include interactive media, learning management systems (LMSs), massive open online courses (MOOCs), distance learning and e-learning platforms, blended learning, educational video games, learning analytics etc.

Educators, convinced of the benefits new technologies carry, are actively exploring technologies and methodologies, though often hindered by factors such as technological acclimatization (Kalogiannakis and Papadakis, 2007; Kalogiannakis, 2008). Utilization of such resources, along with innovative thinking have brought changes to education, creating learning opportunities through activities that would not traditionally be considered educational, such as the usage of robotics to learn math and sciences or the utilization of gaming for the

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development of social, personal and creative skills (Vidakis et al., 2015; 2014).

Traditional assessment with explicit grading systems are still the most prominent method used by educators, as it is thought of as robust. However, this model is considered to be problematic as it fails to reflect accurate information regarding the overall learning process and instead it is focusing on very firm subsections. To overcome these impediments, a more holistic appraisal of learners must be explored, as a more trustworthy system that bares more similarities with realistic situation (Sadler, 2009). Additionally, active collection of learning data, through behaviour and interaction during learning activities, and the resulting analytics, offer the potential of gaining actionable insights (Arnold, 2010; Elias, 2011). The assessment and grading system that can emerge could facilitate a shift in focus of observation, from quizzes and scores to a more holistic and subjective approach.

Furthermore, learning analytics can be a powerful addition to the educators' toolbox of digital and online learning, not only for evaluation, but also for improvement of processes and to bring forth the best in every student. In this paper we work with the creation of raw data for learning analytics in the context of a serious game and the design and implementation of a software library that allows the recording of learning analytics in a serious game developed with the Unity 3D engine.

2 BACKGROUND

2.1 Educational Data

Learning has evolved to a state where personalized, learner-centred experiences are created (Shen et al., 2009). This shift in the educational balance has led to a research interest in the subject of data mining within education. Data collected from historical or operational sources from various educational institutes (dos Santos Machado and Becker, 2003; El-Halees, 2009; Mostow and Beck, 2006) has research value aiming to understand and boost student performance, to assist educators and improve the educational processes in general (Romero and Ventura, 2007).

All this vast amount of educational data that becomes available needs to be analysed and processed so that conclusions can be drawn and learning tools can be enhanced. Furthermore, failure to utilize such data within digital learning processes makes assessment a difficult task, comprised by many layers (Béres et al., 2012). This brings extra obstacles in blended learning settings. Educators must handle assessment in many forms, including physical and digital data at the same time. Recording data during the learning and evaluation process can offer multiple benefits. By utilizing complementing tools for processing and analysing the generated data, valuable conclusions can be drawn.

Thus, simplifying the procedure, accelerating the grading process (Gaur, 2015) and offering insights that educators could possibly overlook during manual handling of all the aforementioned data. Digital educational environments that enclose usage data can be met in official educational institutions such as schools and universities, and unofficial learning settings such as digital educational games. This fragmentation of data is desirable as learning is not confined to a single physical or digital location and it is distributed and diversified through numerous locations and many forms (Vidakis et al., 2014). Through learning analytics, educators and teachers can predict students' performance in the educational process. Educators, by analysing previous data of learners' behaviour, can foresee and develop a clear view of learners' progress in the learning environment. For instance, teachers can predict if a student will pass or fail a course, or if there is a need for additional assistance (Drachen et al., 2013; Prensky, 2001).

Furthermore, in case that a challenge or exercise is too difficult for some learners, educators, assisted by learning analytics, have the opportunity (a) to identify the difficulty and (b) to make necessary changes to the learning process to meet learners needs and thus create a personalized educational process, which meets student's needs. According to the above, fewer students will fail or abandon the learning process (Drachen et al., 2013; Prensky, 2001).

As a result, learning analytics are not only useful for tracking and observing learners in a learning environment. Instead, they offer groundwork for educators to have facts to accurately plan their teaching process and thus to transform the learning environment and the relationships within the classroom, by creating favourable conditions and motivating students (Kalogiannakis and Papadakis, 2007; Kalogiannakis, 2008; Papadakis, 2018). The utmost goal is a powerful, live and adaptable educational procedure with main purpose to educate and train. Digital educational environments can thus act as a learning setting where raw data for learning analytics is generated.

2.1.1 Serious Games Generated Data

Educational or serious games belong to the category of interactive games that have as main objective to educate or train and as secondary objective to entertain (Makarius, 2017). Through the gameplay, players can reach new or enhance existing knowledge on a specific topic (McFarlane et al., 2002; Vidakis et al., 2015). Moreover, serious games improve the player's awareness on a specific topic and help to change its attitude and perspective of this topic. During gameplay each game has the potential to create information, in the form of raw usage data, about player's behaviour inside the game. This information can be thought as traces of the learner, that mirror how he seeks, acquires and comprehends knowledge. Different serious games may record different data, like questions, interactions and completion in order to calculate the learning process outcomes.

We can classify those data as static or dynamic. Static data are not changing overtime, while dynamic do (Serrano-Laguna et al., 2017). Based on the above, standards and specifications were created concerning the creations of raw data from serious games (Makarius, 2017).

2.2 Learning Analytics

Learning analytics can be thought of as systems with a set of operations to store and analyse usage data and create valuable information about students and the learning process (Vidakis et al., 2014). Furthermore, learning analytics can be a collection of data relating to learner's behaviour in a learning environment. The development of learning analytics is used in educational environments for measuring, collecting, analysing, recording and visualizing progress, behaviour and interactions within a learning environment.

By creating learning analytics and studying their results it is possible to enhance and create more effective learning environments (Drachen et al., 2013; Prensky, 2001). To effectively utilize learning analytics, it is crucial that both learners and educators use the outcomes to improve all aspects of the learning procedure (Arnold, 2010). Learning Analytics' elements can be utilized to collect, store and process educational data. In a serious game setting those elements would specifically be represented by a learning analytics component. Traces of player's interactions in the game are being recorded in real time, without affecting the game's flow and in various formats, such as relational databases or structured files.

Future analysis and processing of this data can lead to valuable conclusions regarding the learner, the learning process, and the assessment form which, in turn, can be used to optimize the learning experience. Raw data for learning analytics can be recorded with three different types of triggers (Drachen et al., 2013; Prensky, 2001): (a) Event based: Data are tied to in-game events, (b) State based: Game's information is recorded at a specific frequency, rather than at a specific event, and (c) Initiated events: Recording data depends on data that are switchable, i.e. can be enabled or disabled.

2.2.1 Learning Analytics Frameworks

<u>SCORM</u>: SCORM specification (Advanced Distributed Learning, 2009) is a standard in the development of educational resources, it has been used to create learning analytics and it was introduced by ADL (Advanced Distributed Learning Initiative, n.d.) in 1999. With SCORM specification it is possible to record learner's progress, answers to questions, interactions, completion and success status. Furthermore, it is possible to record interactions, objectives and goals in the context of a serious game. However, there is a huge drawback in the SCORM specification. It is designed to record results and thus although data like interactions can be captured, they cannot be analysed (Drachen et al., 2013; Lukarov et al., 2014).

<u>Activity Streams</u>: Activity Streams specification (W3C, 2017) was developed to solve SCORM's drawback. In this specification actions are being represented as activities, users as actors and actions as verbs. Composing this triple, it is possible to record "who did what" in the context of a learning environment or an educational game. This specification was initially applied to record user's interactions in social networks. IMS Caliper and ADL Experience API (xAPI) were based on this specification (Lukarov et al., 2014; Serrano-Laguna et al., 2017).

<u>IMS Caliper</u>: IMS Specification of Learning Measurement for Analytics (IMS Caliper) (Romero and Ventura, 2007), is a comprehensive specification for learning measurement created by IMS and it was developed by the IMS Global Consortium. Preceding specifications act as the IMS Caliper's core, making the specification robust and offering levels of maturity. This also offers backwards and future compatibility for data and statistics. As a framework, it provides abstract recommendations on the process

of gathering and sharing learning data (Avila et al., 2016). The main logic behind Caliper is the event triggered data triples, which consist of (a) the event, (b) an action, actor or object and (c) the activity context. Those triples are grouped into Metric Profiles that model activities. Transportation and communication of data is achieved through the Sensor API, handling documents in JSON-LD form ("Caliper Analytics Specification," n.d.). Additionally, Caliper describes the services and operations that the Learning Record Store will handle.

Experience API: The Experience API (Rustici Software, n.d.) is based on the Activity Streams' specification and was developed as an open source API. The xAPI was created for the purpose of capturing activities and recording learning analytics within different learning environments. The xAPI, defines each learning activity as a statement. The statement's format is based on Activity Streams' philosophy of "who did what". Statements consisted of actors (users), verbs (actions) and activities (objects). Each statement can include additional information like the resulting outcome of an activity, a timestamp, an API's version and many more (Drachen et al., 2013; Rustici Software, n.d.). Experience API saves statements in a Learning Record Store (LRS). LRS is a data record store, where recorded statements are being saved in sequential order. "The LRS is the heart of any Experience API ecosystem" (Ferguson, 2012; Rustici Software, n.d.). It is responsible for receiving, storing and retrieving learning data about learner's activities, interactions and experiences. Different LRSs can communicate and exchange data with each other. The xAPI's main advantage, as ADL argues, is the freedom that provides in respect to the statements, history, device and workflow.

Experience API provides a huge vocabulary of verbs and activities. Statements follow the philosophy of "who did what" and xAPI is characterized by its cross compatibility throughout different devices. Based on the above and according to the requirements of our system, that are elaborated at the next sections, we chose to base our design and implementation on the Experience API (xAPI) specification.

3 OUR APPROACH

Our goal is to design and develop a software library that can be used by the Unity3D game engine, to log the activity during a gameplay session. We focus on raw learning data of educational games; however, the library can be used by any game created with Unity3D. Our aim is to create an infrastructural component, as presented in Figure 1, with cross-platform compatibility to create and store in-game activity data into a Learning Record Store (LRS). The current implementation of our library is developed with the C# programming language, under the Mono framework, and is based on the stock .NET implementation for xAPI (Rustici Software, 2015). Therefore, it is not compatible with other game engines. Nevertheless, our architecture can be adapted to serve other game engines.

3.1 Ecosystem Architecture

The architecture of our library, that allows the Unity 3D game engine to create gameplay data, is based on a layered modules approach (see Figure 1). Specifically, the design architecture is based on four modules. The first layered module refers to the different devices and platforms that the user can use to interact with the game, such as smartphones, desktop PCs, consoles and tablets (see upper left corner of Figure 1). The next layered module involves the game constituents and the associated user roles (see lower left corner of Figure 1). The third layered module is the core of our library (see centre of Figure 1) with all the necessary procedures to create and record gameplay data, during play. The fourth layered module (see upper right corner Figure 1) incorporates the data types and the dataspace where all the gameplay data are stored as dictated by the xAPI framework and the LRS that is in use. Using a device of any kind, a tablet for instance, a game is being played by a user. This triggers our library to create gameplay data and store these data in an LRS. Then these data can be used to create learning analytics, i.e. statistics and visualizations.

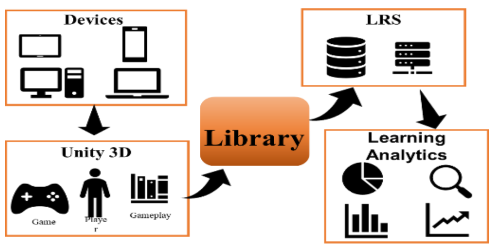

Figure 1: Ecosystem Architecture.

3.2 Unity xAPI Library Architecture

The design of our xAPI library for Unity3D, as presented in Figure 2, consists of five basic components. Those components combine and realise

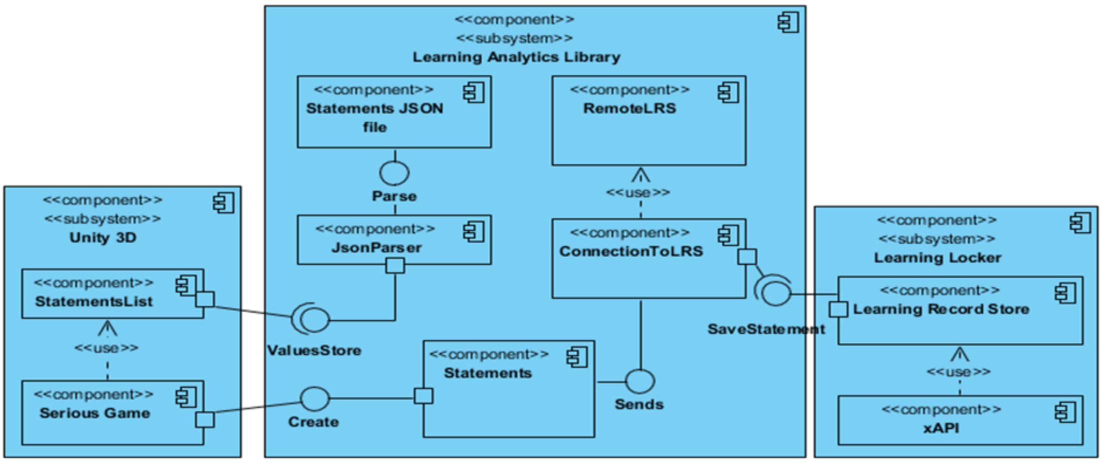

Figure 2: Unity xAPI Library Architecture.

the efforts to parse JSON strings and files, generate xAPI Statements, connect and send the data to the Learning Record Store.

The statements are xAPI entities, represented by the triples but carrying a semantic value with actors, verbs, etc. This JSON structure is illustrated in Exhibit 1. These statements must be prepared for every recordable action within a specific game and then they are dynamically created at playtime, with an event-triggered mechanism.

Exhibit 1: xAPI Statement represented in JSON format


```
{ "id": 4,
  "description": "Statement if answer is correct",
  "verb_id": "http://adlnet.gov/expapi/verbs/answered",
  "verb_language": "en-US",
  "verb_text": "answered",
  "activity_id":
"http://activitystrea.ms/schema/1.0/question",
  "activity_game": null,
  "completion": true,
  "success": true }
```


The LRS that will be used is also predefined, and upon each event that generates a statement, a connection to this LRS is established and the data is sent in JSON format.

4 REPRESENTATIVE SCENARIO: ThimelEdu

To illustrate some of the concepts described so far and to provide insight in our xAPI library for Unity 3D, we modified the game ThimelEdu (Vidakis et al., 2018), adding our library and thus support for xAPI. A Learning Locker (HT2 Labs, n.d.) server was also set up to serve the LRS for the system. Additionally, we describe a representative scenario emphasizing the data being recorded at play time (see Exhibit 2).

Exhibit 2: Paul is a student. His teacher in history, decided to teach Greek ancient theatre through an interactive educational game, called ThimelEdu. Through play Paul will achieve appropriate knowledge via blended learning processes such as study of multimedia material in 3d worlds, discovery learning models and explorative learning (Bruner, 2009). As the lesson starts, Paul must login to ThimelEdu and start navigating inside the virtual 3D world of an ancient theatre. By interacting with scattered points, he can read material, study photos see videos, as well as contemplate and reply to questions. The eduGame finishes when Learner has interacted with all artifacts.

According to our scenario at Exhibit 2, as the lesson starts, learner Paul must login to ThimelEdu and start navigating inside the virtual world of an ancient theatre. This activates several parallel activities through the gameplay. Our collaborative xAPI library for Unity 3D records learner’s data in specific triggered events inside the gameplay. These parallel activities of the gameplay are being described below as play steps. When Paul, logs in the game, Figure 3 (i) (a), an event is triggered. According to this game event our xAPI library for Unity3D creates a statement (see Figure 3 (i) (b)), and through the library the statement is sent to and saved in our LRS. As the game proceeds and Paul moves around the 3D virtual world of the ancient theatre, he reaches a point of interest (see Figure 3(ii) (a)). Points of interest are highlighted with a blue halo to make them visible to the player. When user interacts with a point of interest the user’s first name and last name and as well as the interest point are saved in the LRS (see Figure 3(ii) (b)). The result of Learner Pauls’ interaction with a

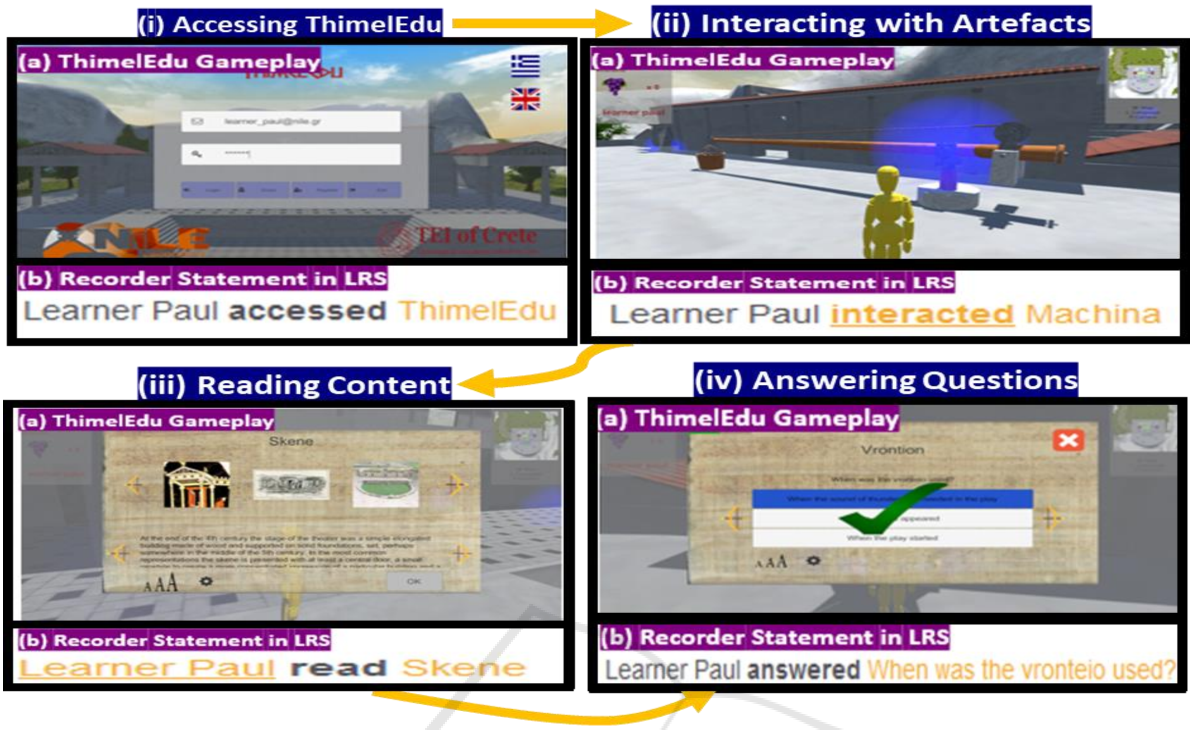

Figure 3: Game Steps.

game artefact (interest point) is that all available material concerning this specific interest point is presented to him in the form of text, photos and video.

Paul is now able to browse through the available material as seen in Figure 3(iii) (a). When Paul has studied all material and presses the “OK” button a xAPI statement is configured and saved in our LRS in the form presented in Figure 3(iii) (b). Once the studying material step is completed then the answering question step is followed for those interest points that include questions. Paul answers a question as shown in Figure 3(iv) (a) and the xAPI statement is adjusted and saved in the LRS, in the form presented in Figure 3(iv) (b).

4.1 Learning Analytics Results

As Paul or any other player/learner, in distinct game instances, wander around the 3D virtual word of ThimelEdu and interact with the various artefacts of the game the LRS is updated with statements in the form of triples as shown in Figure 4. These learning analytics statements hold information about the players’ educational status, progress and learning outcomes. These triples can be used by analytics tools to visualize learner’s behaviour in the learning environment which, in our case, is a serious game, and thus, extract data and conclusions about student’s learning experience. According to these conclusions an educational expert can then intervene in the learning process and adjust the context, the learning or assessment process, the grading algorithm, or any other educational elements to provide a better educational experience with increased benefits for the learner. Furthermore, through studying learning analytics in general, educators can predict students’ performance and draw conclusions that will be used to enhance the educational process according to each student’s individual behaviour.

Figure 4: Saved Statements in LRS.

Educators can change the educational material and content, such as readings, question etc. In addition, serious game developers, based on educators’ conclusions, can adjust games and change gameplay, in order to improve educational tools and

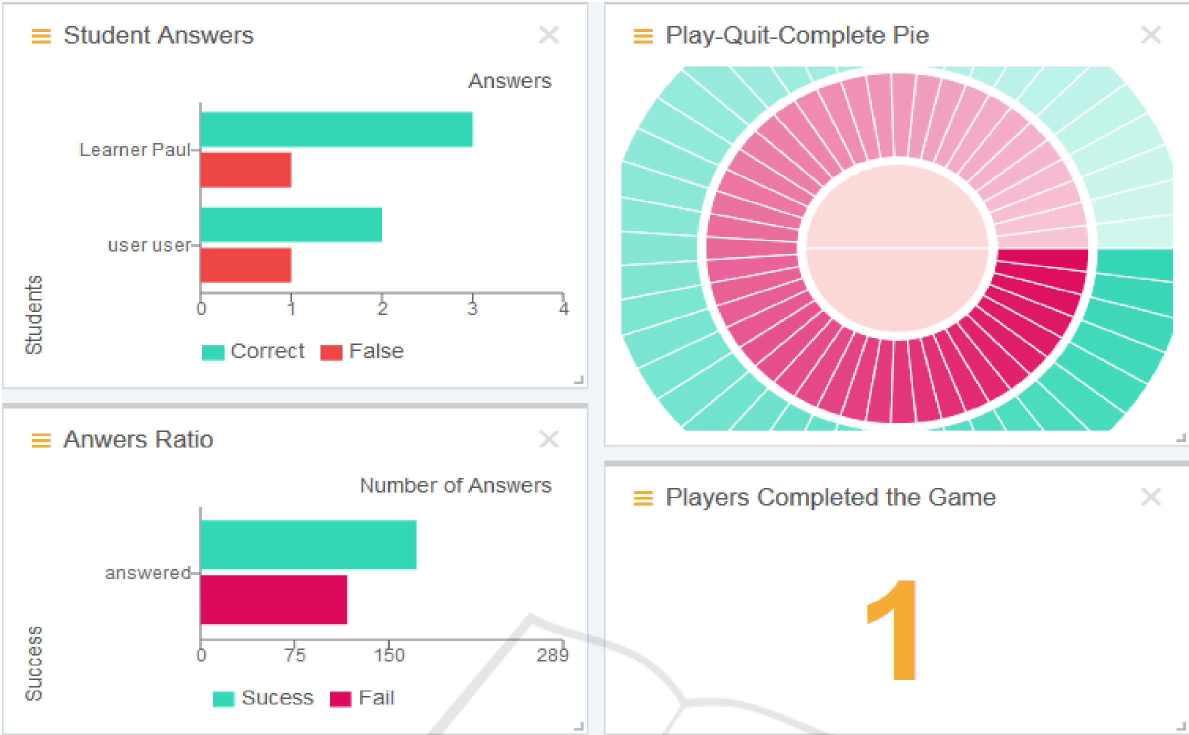

Figure 5: Learning Locker Dashboard.

change the existing teacher-centred learning process philosophy.

Figure 5 shows a dashboard within Learning Locker with indicative visualizations. Upper left corner shows individual students and their successful and failed attempts at answering questions. Bottom left corner shows the overall attempts, during a specified session. Upper right corner shows a pie chart with the number of players that played the game, quit the game without completion and those who completed, over a period of a month. Because of the way the pie is constructed, a rough ratio can also be quickly estimated by the visual representation. Finally, in the lower right corner a counter is showing how many players have completed the game during the specified game session.

5 CONCLUSIONS

According to the current research, learning analytics is a powerful tool for monitoring a learner's behaviour in the new educational era. Its power can assist educators in drawing important conclusions about learner's educational behaviour, process and needs. Although analytics specifications were first developed for social networks, they are now capable to build the fundamentals of new and modern pedagogical environments and therefore of a new e-Learning world. The development of standards and specifications through the years has made developers able to monitor and record learner's behaviour, interactions and knowledge. Experience API is a state-of-the-art specification for the development of learning analytics. The plain structure of Experience API along with the rich vocabulary of verbs and activities, make the library an integral part of learning analytics development. On the other hand, potential obstacles for the learning analytics approach to education with games can be (a) time demanding nature of some games, (b) lack of updated and expensive hardware in schools, (c) price of games and (d) unfamiliar teachers with technology. Future developments include the standardization of our library and the development of a specification for developers that want to use it in their games. Moreover, we plan to run large scale experiments in different classes with pupils of varying ages.

REFERENCES

Advanced Distributed Learning, 2009. SCORM Specification.

Advanced Distributed Learning Initiative, n.d. ADL [WWW Document]. URL https://adlnet.gov/ (accessed 2.20.19).
Arnold, K.., 2010. Signals: Applying Academic Analytics. Educ. Q. 1, 33.
Avila, C., Baldiris, S., Fabregat, R., Graf, S., 2016. Cocreation and Evaluation of Inclusive and Accessible Open Educational Resources : A Mapping Toward the IMS Caliper 11, 167–176.
Béres, I., Timea, M., Turcsányi-Szabó, M., 2012. Towards a Personalised, Learning Style Based Collaborative Blended Learning Model with Individual Assessment. Informatics Educ. 11, 1–28.
Bruner, J. S., 2009. The process of education. Harvard University Press.
Caliper Analytics Specification [WWW Document], n.d. URL https://www.imsglobal.org/sites/default/files/caliper/v1p1/caliper-spec-v1p1/caliper-spec-v1p1.html (accessed 6.27.18).
dos Santos Machado, L., Becker, K., 2003. Distance education: a Web usage mining case study for the evaluation of learning sites. In: Proceedings 3rd IEEE International Conference on Advanced Technologies. IEEE Comput. Soc, pp. 360–361.
Drachen, A., Seif El-Nasr, M., Canossa, A., 2013. Game Analytics – The Basics. In: Game Analytics. Springer London, London, pp. 13–40.
El-Halees, A., 2009. Mining Students Data to Analyze Learning Behavior: A Case Study.
Elias, T., 2011. Learning Analytics: Definitions, Processes and Potential.
Ferguson, R., 2012. Learning analytics: drivers, developments and challenges. Int. J. Technol. Enhanc. Learn. 4, 304.
Gaur, P., 2015. Research Trends in E-Learning. Media Commun. NIU J. Media Stud. ISSN 2395-3780 1, 29–41.
HT2 Labs, n.d. Learning Locker.
Kalogiannakis, M., Papadakis, S., 2007. The dual form of further education of educators in ICT: technological and pedagogical training. In: Constantinou, C., Zaharias, Z., Papaevripidou, M. (Eds.), 8th International Conference On Computer Based Learning in Science. Heraklion, pp. 265–276.
Kalogiannakis, M., 2008. From Learning to Use ICT to Use ICT for Learning: Technological Capabilities and Pedagogical Principles. In: Kobayashi, R. (Ed.), New Educational Technology. New York: Nova Publishers, pp. 13-42.
Livingstone, S., 2012. Critical reflections on the benefits of ICT in education. Oxford Rev. Educ. 38, 9-24.
Lukarov, V., Chatti, M.-A. Thüs, H., Kia, F.S., Muslim, A., Greven, C., Schroeder, U., 2014. Data Models in Learning Analytics. In: CEUR Workshop. pp. 88–95.
Makarius, E.E., 2017. Edutainment. Manag. Teach. Rev. 2, 17–25.
McFarlane, A., Sparrowhawk, A., Heald, Y., 2002. Report on the educational use of games.
Mostow, J., Beck, J., 2006. Some useful tactics to modify, map and mine data from intelligent tutors. Nat. Lang. Eng. 12, 195.
Papadakis, S. 2018. The use of computer games in classroom environment. International Journal of Teaching and Case Studies, 9(1), 1-25
Prensky, M., 2001. Digital Natives, Digital Immigrants. Horiz. 9, 1–6.
Romero, C., Ventura, S., 2007. Educational data mining: A survey from 1995 to 2005. Expert Syst. Appl. 33, 135–146.
Rustici Software, 2015. TinCan.NET.
Rustici Software, n.d. Experience API [WWW Document]. URL https://experienceapi.com/overview/ (accessed 1.26.18a).
Rustici Software, n.d. The Learning Record Store [WWW Document].
Sadler, D.R., 2009. Indeterminacy in the use of preset criteria for assessment and grading. Assess. Eval. High. Educ. 34, 159–179.
Serrano-Laguna, Á., Martínez-Ortiz, I., Haag, J., Regan, D., Johnson, A., Fernández-Manjón, B., 2017. Applying standards to systematize learning analytics in serious games. Comput. Stand. Interfaces 50, 116–123.
Shen, L., Wang, M., Shen, R. 2009. Affective e Learning: Using “Emotional” Data to Improve Learning in Pervasive Learning Environment. Educational Technology & Society, 12 (2), 176–189.
Vidakis, N., Barianos, A., Xanthopoulos, G., Stamatakis, A., 2018. Cultural Inheritance Education Environment: The Ancient Theater Game ThimelEdu. In: 12th European Conference on Games Based Learning, ECGBL 2018. pp. 730–740.
Vidakis, N., Christinaki, E., Serafimidis, I., Triantafyllidis, G., 2014. Combining ludology and narratology in an open authorable framework for educational games for children: The scenario of teaching preschoolers with autism diagnosis. Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics) 8514 LNCS, 626–636.
Vidakis, N., Syntychakis, E., Kalafatis, K., Christinaki, E., Triantafyllidis, G., 2015. Ludic Educational Game Creation Tool: Teaching Schoolers Road Safety. In: Antona, M., Stephanidis, C. (Eds.), Universal Access in Human-Computer Interaction. Access to Learning, Health and WellBeing, pp. 565–576.
W3C, 2017. Activity Streams 2.0 [WWW Document]. URL https://www.w3.org/TR/activitystreams-core/ (accessed 02.20.19).