Simplifiying Serious Games Authoring and Validation with uAdventure and SIMVA

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***Abstract*—The e-UCM group is working to simplify the processes of both creation and scientific validation of educational adventure games, by making the entire process of game creation, data acquisition, and analysis more transparent and integrated. This paper presents the integration of the uAdventure authoring tool with SIMVA, a tool to simplify validation experiments, thus encompassing the full process of serious games authoring and validation.**

Keywords- serious games, learning analytics, serious games validation, authoring tools, game-based learning

I. INTRODUCTION

For almost 12 years, the e-UCM research group has worked on different open code software tools that place teachers at the center of the development and validation process of serious games (SGs) [1], [2]. The goal is to provide teachers with easy-to-use tools that they can apply without in-depth technical knowledge. To simplify the authoring process, we first developed eAdventure [3], a game authoring platform that has recently evolved into uAdventure (uA). In parallel, we have worked on a learning analytics platform, RAGE Analytics [4], which allows the assessment of SGs, and of the students that play them. We facilitate this approach in uA using *game learning analytics* (GLA) [5], [6]. GLA enables richer game-based educational experiences. For example, by allowing interventions to help students that get stuck in the game or by assisting teachers to better control and understand the game application in the classroom. Teachers have access to per-user and per-group metrics such as student progress or in-game milestones reached.

However, applying GLA to serious games is complex, error-prone, and fragile: many technical details must be considered, including communication between components, and correct identification of games, gameplay sessions, and players. Any small glitch can cause the whole process to fail without teachers or researchers knowing very well why or being able to solve it. These issues hinder GLA adoption by non-technical users in uncontrolled, highly-diverse environments such as schools. Additional complications arise even before the games are deployed: the formal validation of the actual educational impact of SGs is usually done by carrying out experiments where players are asked to answer pre-game and post-game questionnaires. While the key aspect of that validation is the definition of the tests, carrying out the experiments themselves is also difficult, error-prone, and cumbersome. To assist with SG validation experiments, we developed a supporting tool called SIMVA [4], [7], [8], which can partially automate the creation of online questionnaires for SG evaluation and its relation with the GLA data.

This work describes another step towards simplifying the whole process of SG authoring and validation: the integration between the uA authoring tool and SIMVA, an experimental validation support tool. Section II describes our previous workflow when authoring and validating SGs, while Section III describes how we are evolving these tools to address their limitations and create a unified authoring and validation experience. Finally, Section IV provides some conclusions and future lines of work.

II. AUTHORING AND VALIDATION OF SERIOUS GAMES USING E-UCM TOOLS

The design phase is the first step towards SG development. Stakeholders in charge of this SG design, such as teachers and educational designers (hereafter just authors) must consider not only educational aspects, such as how students will be assessed through the game but also the capabilities of the authoring tool, which dictate the set of available game mechanics. Then uA allows for the creation of "point and click" conversational games, and therefore supports the usual mechanics of this game genre: players can explore scenarios, participate in conversations by choosing responses, and ultimately solve logical puzzles involving objects and interactions with other characters.

Once a game has been designed and developed with uA, the next step is to carry out an evidence-based validation of its effectiveness. This validation is usually performed based on the comparison of players' results in two formal external questionnaires, conducted before and after the gameplay, in what can be called pretest-game-posttest experiments [9]. To help with this process, we developed the SIMVA tool [7], [8], which allows the creation of one or more experimental

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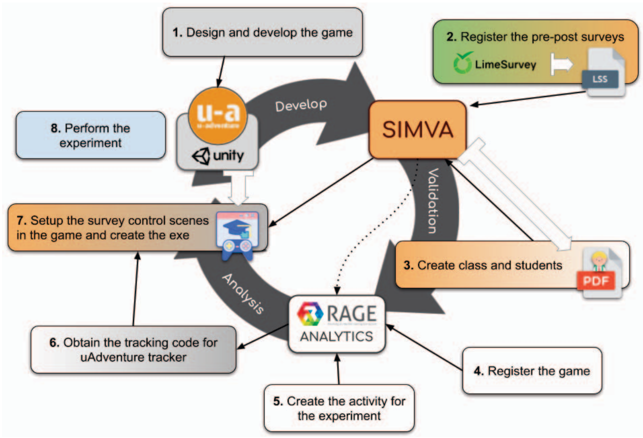

Fig. 1. uA + SIMVA + RAGE Analytics game validation process.

users' groups, managing and tracking the state of pre- and post- game tests, and collecting GLA data during and after the gameplay – a feature that is especially interesting when lacking an analytics server or experiencing unreliable internet connectivity.

SIMVA integrates a LimeSurvey (LS) [10] installation to manage questionnaires. Researchers must first author the pre and post surveys in LS, and then import them into SIMVA (step 2 of 8 in Fig. 1). Then, they set up an experimental group, with participants identified using randomly-generated alphanumeric tokens that will allow all tasks performed by the same participant to be labeled as such; and configure the LS surveys to only allow participation of players with valid tokens (step 3 in Fig. 1). Finally, to finish the setup of the experimental group, researchers can download a PDF document with the list of users' token codes, which can then be physically distributed among the participants for use during the experiments. SIMVA controls, for all participants, the specific tasks that they have performed, such as pretest, game, or posttest. Also, special template game scenes are available for authors to download, customize, and integrate into their uA games. These templates are a middleware that establishes communication between the uA game and the SIMVA server in a transparent way.

Analytics integration in uA is done using a parametrizable tracker component. When enabled in uA, this component automatically generates and sends xAPI-SG traces with relevant game events to the configured analytics server, typically an instance of RAGE analytics. The RAGE analytics dashboard then provides near real-time insights into players' actions and progress. SIMVA also automates class and student registration in RAGE Analytics (step 3 of Fig. 1). However, uA authors must still register the game, create a course, and set up the activity manually (steps 4 and 5 of Fig. 1). With the tracking code obtained in step 5, authors can proceed to step 6: configure uA's tracking component. Next, in step 7, the game authors provide developers with the survey tokens generated by SIMVA as part of step 2. With the identifiers, the developer configures the survey management scenes in uA, allowing the game to check whether its players have filled out the pre-test survey, played

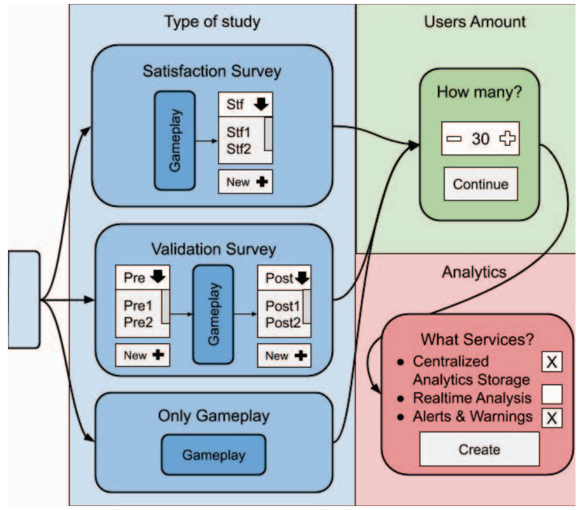

Fig. 2. Interface mockup of the three steps needed in order to setup a validation and/or assessment process in uA.

the game, and/or answered the post-test survey. Finally, as a backup to deal with the diversity of school environments, the game can also upload a backup copy of the GLA traces to SIMVA after the gameplay.

As a result, teachers can link their games to the corresponding validation experiments. Linked games will then show an initial screen where each player must enter their unique SIMVA-generated token to access the pretest, the game, and finally, the posttest. Additionally, during the experiment (step 8), the teacher will be able to access a dashboard to track the activity and observe the different decisions and progress of the players. After completing the experiment, the teacher can download all the responses as well as the GLA data from SIMVA for further analysis.

III. UNIFIED AUTHORING AND VALIDATION EXPERIENCE

We have used the configuration and setup process illustrated in Fig. 1 in several experiments, and consider it still challenging for less technically-oriented users, as there are several critical points where errors can compromise the entire validation and evaluation process. For example, failure to update a tracking-code can lead to misclassification or even loss of data. This section presents improvements to tackle both human and technological risk factors.

Ideally, the process of setting up the infrastructure for the validation and evaluation of an SG for the educator or educational researcher could be as simple as pressing a single "*all-in-one button*". By pressing it, any uA-authored SG would be ready to be validated. We are creating a wizard to guide the author during the three main steps of the development and validation process: i) choosing the type of study to be set up, ii) defining the number of users that will participate, and iii) selecting the analysis features to use. **¡Error! No se encuentra el origen de la referencia.** presents a mockup of this process where three types of studies are available, the number of users is established using a numerical selector, and multiple optional analysis services can be activated or deactivated depending on the teacher's needs. Behind the scenes, uA requests SIMVA to configure and integrate all required tools. Based on wizard selections, the uA integration component: 1) creates a teacher account in SIMVA, or alternatively uses the uA author's login as an already-existing teacher; 2) generates students' users accounts using unique, random alphanumeric tokens; 3) creates a study group including both students and the teacher; 4) creates, within the study group, a study of the selected type; 5) if the study type includes surveys, the user may choose one of the survey templates or be redirected to create a new one; 6) depending on the chosen analytics capabilities, SIMVA will store the xAPI-SG traces and/or RAGE Analytics that will be configured to perform the near real-time analysis; and finally 7) creates intermediate game scenes, linked together with the current available game scenes, to orchestrate the user login and survey participation as required for the chosen study type. Additionally, a printable PDF with unique tokens to distribute to the users for the experiment is given. After the experiment is carried out, all gameplay traces and survey results (if applicable) will be downloadable from both uA and SIMVA.

Different stages of development of a serious game can benefit from different GLA uses. For instance, during the formative validation of a serious game, authors may wish to validate certain hypotheses regarding gameplay. To do so, it may be enough to simply collect some game metrics to analyze. This collection can be easily performed with uA. Once an SG is validated, it may be possible to apply machine learning techniques [11] to gain deeper insights on how students play and learn. At this point, data scientists usually require performing some exploratory analysis on the data before identifying the actual method that works best. Finally, teachers deploying the validated game in their classrooms may benefit from accessing other real-time metrics while their students are playing the game. To support these use-cases, we have begun to separate RAGE Analytics into several subcomponents, allowing us to move game analytics storage into SIMVA while keeping the near real-time capabilities inside RAGE Analytics. Additionally, by providing a file system interface (HDFS) for storage, analytics data is now easier to access from standard data science tools such as Jupyter Notebooks.

IV. Conclusions and Future Work

The authoring and validation of serious games is a complex process. The integration of uAdventure, SIMVA, and RAGE Analytics seeks to provide a much simpler, robust and integrated flow. First, we have brought management and authoring of surveys directly into SIMVA, avoiding human error when manipulating survey files Second, and regarding RAGE Analytics, game and activity creation, tracking-code retrieval, and linking are now automated by SIMVA, making them much easier to apply even by non-expert users. Thirdly, the integration of scenes that bind uA and SIMVA together has been automated, including all end-user access control. We are working on several further improvements. For example, we are working on partial automation of the analysis of pre-post surveys, allowing quick feedback on game effectiveness. For deeper insights, we are testing integration of Jupyter Notebooks, which would allow exploratory analysis without leaving SIMVA. Finally, we are also working on a mechanism to streamline deployments so that students can complete a full evaluation by following a single URL, seamlessly jumping from one activity to the next. Options to achieve this include deploying games as HTML, or enabling a URI scheme which would automatically run the desired game with the specified user already authenticated in the system, similar to "uA://examplegame?authtoken=userauth".

SIMVA's latest version has great potential as an environment for creating games that can be validated following a simple, reliable, and easily configurable process, greatly increasing the value of the uAdventure tool and the games generated with it.

Acknowledgments

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References

[1] Á. del Blanco, J. Torrente, E. J. Marchiori, I. Martínez-Ortiz, P. Moreno-Ger, and B. Fernández-Manjón, "A framework for simplifying educator tasks related to the integration of games in the learning flow," *Educ. Technol. Soc.*, 2012.

[2] A. Calvo-Morata, C. Alonso-Fernandez, M. Freire-Moran, I. Martinez-Ortiz, and B. Fernandez-Manjon, "Game Learning Analytics, Facilitating the Use of Serious Games in the Class," *IEEE Rev. Iberoam. Tecnol. del Aprendiz.*, vol. 14, no. 4, pp. 168–176, Nov. 2019.

[3] I. Martínez-Ortiz *et al.*, "Addressing Serious Games Interoperability: The eAdventure Journey," *J. Adv. Distrib. Learn. Technol.*, vol. 1, no. 1, pp. 60–76, 2013.

[4] e-ucm, "e-UCM GitHub Page," 2017. [Online]. Available: https://github.com/e-ucm/.

[5] M. Freire, Á. Serrano-Laguna, B. M. Iglesias, I. Martínez-Ortiz, P. Moreno-Ger, and B. Fernández-Manjón, "Game Learning Analytics: Learning Analytics for Serious Games," in *Learning, Design, and Technology*, Cham: Springer International Publishing, 2016, pp. 1–29.

[6] C. Alonso-Fernández, A. Calvo-Morata, M. Freire, I. Martínez-Ortiz, and B. Fernández-Manjón, "Applications of data science to game learning analytics data: A systematic literature review," *Comput. Educ.*, vol. 141, 2019.

[7] I. J. Perez-Colado, C. Alonso-Fernández, A. Calvo-Morata, M. Freire, I. Martínez-Ortiz, and B. Fernández-Manjón, "Simva: Simplifying the scientific validation of serious games," in *9th IEEE International Conference on Advanced Learning Technologies (ICALT)*, 2019.

[8] C. Alonso-Fernández, I. J. Perez-Colado, A. Calvo-Morata, M. Freire, I. Martinez-Ortiz, and B. Fernández-Manjón, "Using Simva to evaluate serious games and collect game learning analytics data," in *LASI Spain 2019: Learning Analytics in Higher Education*, 2019.

[9] A. Calderón and M. Ruiz, "A systematic literature review on serious games evaluation: An application to software project management," *Comput. Educ.*, vol. 87, pp. 396–422, Sep. 2015.

[10] The LimeSurvey Project Team, "LimeSurvey," 2013. .

[11] C. Alonso-Fernández, R. Caballero Roldán, M. Freire, I. Martinez-Ortiz, and B. Fernández-Manjón, "Predicting students' knowledge after playing a serious game based on learning analytics data: A case study (in press)," *J. Comput. Assist. Learn.*, 2019.