What serious game studios want from ICT research: identifying developers' needs

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Abstract. Although many scholars recognise the great potential of games for teaching and learning, the EU-based industry for such "serious" games" is highly fragmented and its growth figures remain well behind those of the leisure game market. Serious gaming has been designated as a priority area by the European Commission in its Horizon 2020 Framework Programme for Research and Innovation. The RAGE project, which is funded as part of the Horizon 2020 Programme, is a technology-driven research and innovation project that will make available a series of self-contained gaming software modules that support game studios in the development of serious games. As game studios are a critical factor in the uptake of serious games, the RAGE projects will base its work on their views and needs as to achieve maximum impact. This paper presents the results of a survey among European game studios about their development related needs and expectations. The survey is aimed at identifying a baseline reference for successfully supporting game studios with advanced ICTs for serious games.

Keywords: Serious game·game industry·technology·game engine·interoperability·innovation·RAGE

1 Introduction

Serious games are games for non-leisure purposes [1]. Their potential for teaching and learning has been widely recognised. Thus far, however, seizing this potential has been problematic. While the leisure games industry is an established industry dominated by major non-European hardware vendors (e.g. Sony, Microsoft and Nintendo), major publishers, and a fine-grained network of development studios, distributors and retailers, the serious games industry displays many features of an emerging, immature branch of business: weak interconnectedness, limited knowledge exchange, absence

of harmonising standards, limited specialisations, limited division of labour and insufficient evidence of the products' efficacies [2,3]. The serious gaming industry is distributed over a large number of small independent players. There is no clearly functioning serious gaming sector with defined product and service qualities, competing suppliers and active users [2]. Growth figures for the wider domain of game-based learning are estimated to be in the region of 3-4 % per year until 2017 [4], which is well below the comparative estimated annual growth rate of 7% of the leisure games market [5].

Still, conditions for a wider uptake of serious games are favourable. End-user connectivity as well as the market penetration of PCs and handheld devices do not present any barriers to the adoption of games. In recent years smartphones, tablets and social media have radically changed the media landscape outside school. Teachers, learners and parents urge schools to include these media in their school lessons and curriculum. The financial barriers for game development have receded as advanced tools for graphics design, media production and game creation have become accessible at low cost indeed some are available free of charge. There is increasing, empirical evidence of the effectiveness of serious games for learning and teaching [6], which is a critical factor in the acceptance of games as a learning tool.

The European Commission has designated serious games as a priority topic in its Horizon 2020 European Framework Programme for Research and Innovation. It envisions a flourishing serious games industry that both stimulates the creation of jobs in the creative industry sectors and helps to address a variety of societal challenges in education, health, social cohesion and citizenship. The RAGE project, which is funded as part of the Horizon 2020 Programme, is a technology-driven research and innovation project that will make available ICTs for supporting game studios at the development of serious games. In order to identify the needs and expectations of European game studios the RAGE project has carried out a series of in-depth stakeholder interviews with game development companies. This paper presents the main outcomes of this needs assessment grounded and interpreted within the context of game research and the game industry. Firstly this paper introduces the RAGE project and explains the motivation for this survey. Thereafter, the paper explains the conceptual underpinning of the survey and the method applied. It summarises the outcomes and concludes with a brief discussion.

2 The RAGE project

The RAGE project (rageproject.eu) is a pan-European initiative to support the development of serious games. It is coordinated by the Open University of The Netherlands and includes 19 key partner participants from the game industry, the education sector and research centres from 10 European countries: Austria, Bulgaria, France, Germany, Italy, Portugal, Romania, Spain, United Kingdom and The Netherlands. RAGE will develop and validate a number of self-contained software modules that game developers can use for enhancing the pedagogical quality of their games. The software modules will facilitate the processing of data from logging and input devices to

allow for learning analytics, emotional states capturing and stealth assessment of players, and enable strategic interventions and social representations that support personalised learning, game balancing, procedural animations, language analyses and syntheses, interactive storytelling, and other functions. One of the principal technical challenges of RAGE is to ensure interoperability of the software modules across the variety of game platforms that are used by game studios. While aiming for the widespread and sustained exploitation of the anticipated new technologies RAGE from the outset has deliberately engaged its main stakeholders in a co-design process. . Importantly, we want to avoid the common mismatch between required and delivered ICT that can be observed everywhere, with costs of failure up to 2.5 % of the Gross National Product [7,8]. The current survey is the first of the on-going stakeholder consultation required to identify developers' baseline needs and requirements.

3 Conceptual framing

Game studios are a branch of creative industries, a term that emerged in the 1990s to connect the arts and other cultural activities with emerging digital technologies and the associated knowledge economy [9]. The creative industry product is innovative rather than routine, and can be characterised by originality, technical professional skill, uniqueness and quality [10]. Moreover the creative industries are expected to increasingly become the main driver of innovation and societal change, by the products and services they provide and as means of originating and sharing new ideas, knowledge and ways of working [11,12]. While a variety of game market analyses and outlooks are available on a commercial basis - usually only available on a premium subscription basis - these tend to singularly cover the business perspective that is, they present macro-economic figures, e.g. market volumes, growth rates and segmentation and largely neglect other perspectives (cf. newzoo.com, superdataresearch.com, npd.com, forrester.com, idate.org). Additionally, most resources refer to the demand side of the overall game market, not the serious game market, but even less data about the supply side is available that would reveal how game studios view and deal with emerging technologies. When it comes to technology-driven innovation, however, a wider range of factors should be considered, including technology usage and the associated competences and knowledge management [13]. As RAGE aims to introduce a wide range of innovative technologies in the gaming sector the primary goal of our study is to understand the game studios´ practices, strategies and expectations with regard to emerging technologies and to clarify how game studios - as part of technology-driven creative industries - balance production routines and innovative approaches. Figure 1 presents the conceptual model that was used for guiding this survey. Placing the game studios at the centre, it is important to collect details about 1) the games they deliver and 2) the customers and end-users that will use the games. Furthermore, 3) validation refers to the tools and mechanisms for establishing the effectiveness of the games for their purposes. Among the studios' means of production we distinguish 4) the pedagogical strategies that they apply, 5) the knowledge and information resources they rely on, and 6) the technological infrastructure and tools that they cur-

rently use for building the games. The latter is the main focus with in particular 6a) the platforms and programming languages the game studios use, the ways they deal with 6b) interoperability issues and how they view 6c) emerging technologies.

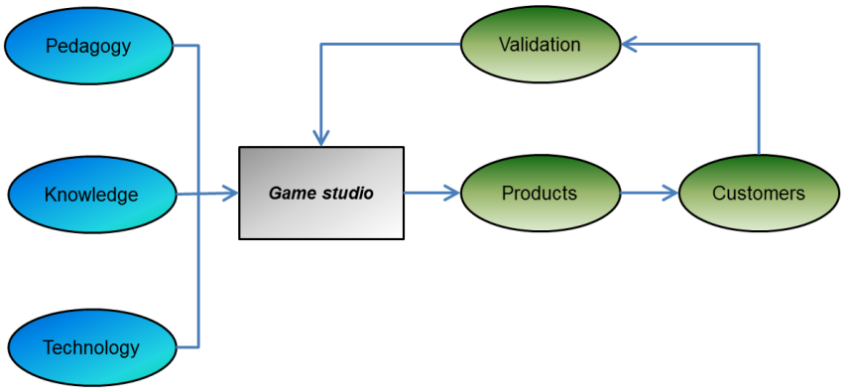

Fig. 1. Conceptual framework for the survey

4 Method

For this qualitative study we have opted for structured interviews rather than a questionnaire approach, as the latter does not match the in-depth detailed nature of the study and may have produced poor responses. A set of questions was elaborated for each of the framework components explained above. The final interview version contained 170 questions (61 yes-no questions, 73 open-ended questions and 36 Likert ratings). For practical reasons the interviews were arranged through online communications (Skype or phone) and the interviewers used an online questionnaire to guide the interview and to record the answers. This online questionnaire was not disclosed to the participants, however, in order to preserve the pursued interview setting. A priori, two test interviews were carried out to check for clarity and duration. Interview duration was typically less than one hour. Through the RAGE partner network we engaged with 21 game studios from 10 European countries. The average studio staff count was 32, which was strongly biased, however, by two large companies with around 200 employees. The other 19 studios have an average size of 14 employees (SD=9). The respondents had senior positions in the studios (mean: 14 years of experience, SD= 9), either as CEO, creative director, owner, programmer, producer or as sales manager. With respect to the processing of the Likert scale data, which are ordinal, we follow Norman [14] in allowing parametric statistics for these. This results in despite the qualitative nature of the Likert labels, quantifiable scores that can be represented with the arithmetical mean, standard deviation, and estimated standard error of the mean, respectively, is it conditional to normality checks. The Likert scales (strongly disagree, disagree, neutral, agree, strongly agree) data were all converted into a linear metric at the interval [-1, +1].

5 Outcomes

The results of the survey are summarized below, in accordance with the different components of the outlined conceptual framework.. Emphasis will be on the technology perspective.

1. The games: What type of games do the game studios produce?

The game studios in the sample indicate that they produce games for learning (reported by 76% of the studios), entertainment games (57%) and games for other purposes (67%). Game genres that were reported, included adventure games, strategy games, quiz-based games, puzzle games, action games, both in 2D and 3D. The predominant player or learner mode was identified by most studios as being single player mode. Half of the studios also develop multiplayer games.

2. The customers: Who are the studios' target customers and end-users?

The studios address diverse customer categories. They sell their games to companies (reported by 48% of the studios), public organisations (43%), education providers (38%), individuals (38%) and publishers (19%).

3. Validation: How do studios validate the effectiveness of their games for learning?

Most game studios claim to deliberately assess the effectiveness of their games for achieving pursued learning outcomes. They mostly rely on data that can be collected easily from game runs, e.g. logging and trace data, quizzes in the game, level achievement, internal ratings and performance scores. Some use (quick) questionnaires or rely on player community feedback. Three companies reported using randomised controlled trials collecting evidence. The validity of the approaches could not be established in this survey.

4. Pedagogy: What pedagogical strategy do game studios use, if any?

When asked for their preferred approach toward pedagogy the game studios reported experiential learning pedagogy most often (76%). Other approaches mentioned are guided instruction (62%), quiz-based feedback (48%) and problem solving (43%). No detailed information was collected as to how game studios then further detail and implement these strategies in the games, and what level of expertise about instructional design they possess. In addition the studios were asked to rate the importance of diverse pedagogical strategies. Figure 2 presents the Likert rating results converted to the [-1,1] interval. Horizontal bars reflect the standard error (not the standard deviation). Fundamentally all strategies receive some importance. The highest ranked strategies are natural feedback and debriefing after the game. Apparently, the game developers 's priority is to avoid any interruptions of the game play, in order to preserve flow. Guidance and instruction during the game are rarely used, even though a vast body of evidence in instructional research demonstrates the inferiority of minimal guidance strategies [15].

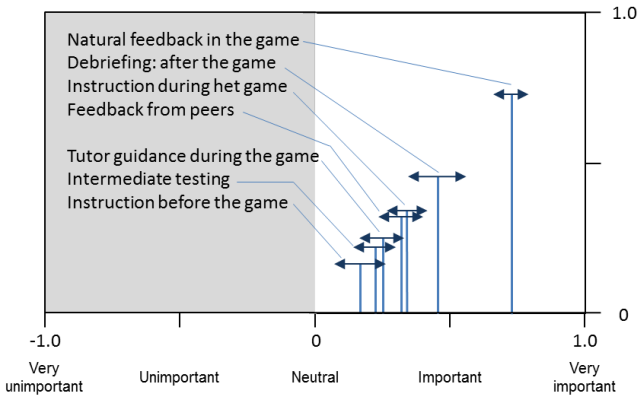

Fig. 2. The importance of pedagogical strategies

5. *Knowledge: What are important information needs?*
Participants were asked to rate the importance of diverse information and knowledge resources. The ratings are presented in figure 3.

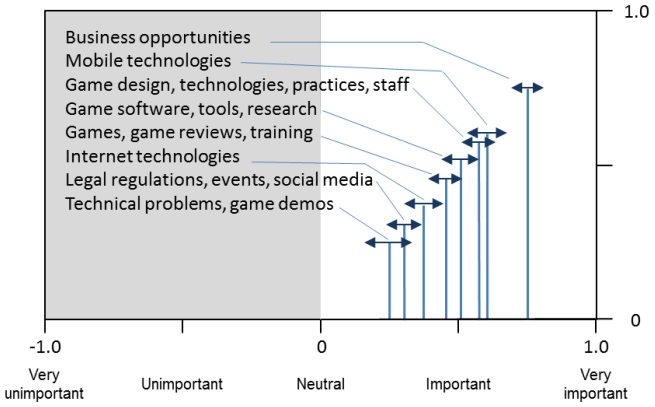

Fig. 3. The importance of various information and knowledge resources

Although the game studios appreciate a wide variety of knowledge resources, highest scores are assigned to resources about business opportunities, mobile technologies, game technologies, game design, best practices and potential new personnel. By answering the open-ended questions the game studios indicated the use of various external repositories (e.g. Unity Asset Store, Turbosquid, Three.js) for collecting game content (3D objects, textures, sound objects). Stock sites are regularly searched for reusable graphics and photographs. Software is retrieved from GitHub, SourceForge, Bitbucket and Google play game services. Software troubleshooting is supported by consulting Stack Overflow as well as support sites and communities of game engine providers (Marmalade, Sony, Unreal). In addi-

tion game studios use online educational content and courses, for instance Moocs from Coursera and iVersity.

6. Technology: How do the game studios deal with technology?

The larger part of the interview was spent to the technological infrastructure and tools that game studios use for building the games.

6a) What are the platforms and programming languages that the studios use?

Windows was found to be the most popular operating platform (62%), followed by Mac (38%) and Linux (14%). For mobile platforms Android (90%) and iOS (86%) are the most popular ones. A number of game studios reported the development of games for computer web browsers (62%); the development of mobile browser games is reported by 33%. Only 24% of the game studios expressed an interest in developing console games. The significantly most popular game engine among the game studios is Unity (76%), followed by Flash (38%), and then Cocos2D (24%). This observed dominance of Unity is consistent with other sources, e.g. [15]. The most popular programming language among the studios is C# (71%), followed by C++ (67%), JavaScript (48%), objective C (33%) and Java (33%), which is quite similar to the latest Redmonk programming languages rankings [16].

6b) Interoperability: What (learning technology) standards are used?

The studios reported a number of interoperability issues, or more specifically integration issues, such as linking games to existing systems (e.g. corporate systems, learning management systems), linking games with existing user data bases, compatibility problems with web browsers, portability to new hardware, and the integration and repurposing of existing game objects. SCORM was the predominant learning technology standard that was mentioned (43%). Further interest was reported for xAPI (14%). Whilst a number of the respondents highlighted interoperability as being challenging and of interest, very few identified or used any other Technology Enhanced Learning (TEL) standards such as those developed by IMS for example Learning Tools Interoperability (LTI) or Question and Test Interoperability (QTI) which would enable seamless data integration with learning management systems or virtual learning environments.

6c) Emerging technologies: How do game studios judge emerging technologies?

Respondents were asked to rate importance of various emerging technologies for serious game development. The results are in figure 4. As can be observed from figure 4 all technologies receive some positive interest. Highest scores are assigned to learning analytics, the real time tracking of learning progress, adaptive gameplay and game evaluation, respectively, which all well exceed the level of importance. Other technologies seem to receive slightly more scepticism. Standard deviations are up to 0.7. This indicates that quite some studios dismiss these emerging technologies.

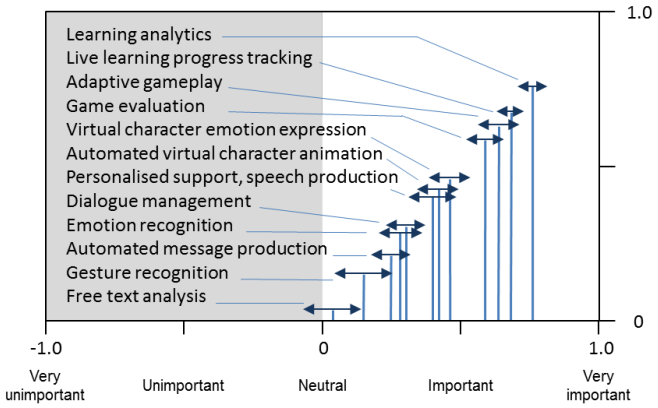

Fig. 4. Importance of various emerging technologies

Through open-ended questions the participants were invited to expand on their scores. In many cases the answers were of tautological nature: we think technology X is important because we want our games to include it. In addition, positive scores were substantiated by the expectation that a particular technology would enhance the games' quality, either by allowing for better game play, increased credibility, supporting motivation or improve the learning. Commercial potential and practicability were also mentioned as important factors. Negative scores were mainly motivated by doubts about the added value, and anxiety for complexity and cumbersome implementation. When it comes to emerging technologies game studios cautiously balance the pros and the cons in the context of their individual business.

6 Discussion and conclusions

The objective of this survey was to provide a baseline reference for the alignment of ICT research and the serious game industry. Generally it is observed that the game studios expressed overall quite positive judgements about the importance of knowledge resources, pedagogical models, product validation and newly emerging technologies. Yet, the study allowed game studios to express a ranking of priorities, which could then inform the research ICT agenda. With respect to customers, the games, tools and infrastructure the game studios display the unrestricted diversity and fragmentation identified previously as a main characteristic of the serious game sector [2,3,4]. Major platforms are targeted, including mobile platforms. Many studios develop browser games. Exceptional is the predominance of the Unity game engine. Game consoles are avoided by most of the studios as platforms for serious games.

Serious game studios indicated the significant importance of pedagogy and the validation of the games´ pedagogical effectiveness. Various pedagogical strategies were appreciated. Experiential learning was reported as the most popular approach used in the games. Natural feedback and debriefing (after the game) were ranked as the most important strategies, whereas guidance and instruction during the game are rarely used. Apparently, the game developers' priority is to avoid interruptions of the game

play, in order to preserve flow. This seems to conflict, with a vast body of evidence in instructional research demonstrating the inferiority of minimal guidance strategies [17]. Further, serious game studios tend to present their games as the playful alternative for common teaching methods, which they (and many others) consider boring. They claim that learning should be and can be fun, but should then avoid any resemblance to traditional instruction. They seem to neglect the notion that sometimes instruction can be fun, and games can be boring as such [18].

Most game studios claim to test their games' effectiveness for learning. Some even use randomised controlled trials for collecting evidence. Asking serious game studios if their games are pedagogically sound and effective, is problematic, a highly coercive question, which they can hardly avoid answering affirmatively. But the depth and validity of the approaches that the studios claim to apply could not be established in this survey. It remains unclear what game studios actually know about pedagogical strategies. Puritans may comment that the applauded experiential learning approach is in fact not a pedagogical strategy, but a theory of learning. More detailed probing is needed into the operational significance of the studios' pedagogical approaches.

Although all knowledge resources received a positive appreciation, game studios assigned highest priority to information that enhances their business opportunities. Furthermore information about mobile technologies, game technologies, game design, best practices and potential new personnel received high ratings. A variety of external repositories are already accessed to support the work. Game studios designated interoperability as a major issue and many experienced practical difficulties when connecting their games to other systems. Despite these problems, only SCORM and to a lesser extent xAPI were mentioned as being used, and only a small number of studios referred to other Technology Enhanced Learning standards that might help to resolve the issues. It may suggest that the game studios have only limited awareness of these standards or that they do not consider (TEL) interoperability as an urgent topic. This may readily be associated with the fact that developers tend to perceive their applied games as "stand alone" creative solutions that offer learning activities independent of institutional learning management systems or virtual learning environments. With respect to the importance of emerging technologies highest rankings were given to learning analytics, real time tracking of learning progress, adaptive gameplay and game evaluation, respectively. Game studios are generally open and positive toward new technologies, but equally critical . They look for added value in terms of better games or commercial potential, and at the same time fear complex and cumbersome implementation.

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8 References

1. Abt, C.: Serious games.. Viking Press, New York (1970)
2. Stewart, J., Bleumers, L., Van Looy, J., Mariën, I., All, A., Schurmans, D., Willaert, K., De Grove, F., Jacobs, A., Misuraca, G.: The Potential of Digital Games for Empowerment and Social Inclusion of Groups at Risk of Social and Economic Exclusion: Evidence and Opportunity for Policy, Joint Research Centre, European Commission (2013)
3. García Sánchez, R., Baalsrud Hauge, J., Fiucci, G., Rudnianski, M., Oliveira, M., Kyvsgaard Hansen, P., Riedel, J., Brown, D., Padrón-Nápoles, C.L., Arambarri Basanez, J.: Business Modelling and Implementation Report 2, GALA Network of Excellence, www.galanoe.eu (2013)
4. Adkins, S.S.: The 2012-2017 Worldwide Game-based Learning and Simulation-based Markets. Key Findings from Recent Ambient Insight Research, Serious Play Conference 2013. Ambient Insight: Monroe, WA (2013). Retrieved from www.ambientinsight.com/Resources/Documents/AmbientInsight_SeriousPlay2014_WW_2013_2018_GameBasedLearning_Market.pdf
5. PWC: Global Entertainment and Media-Outlook: 2012-2016. PriceWaterhouse-Coopers (2012)
6. Connolly, T.M., Boyle, E.A, MacArthur, E., Hainey, T, Boyle, J.M.: A systematic literature review of empirical evidence on computer games and serious games. Computers & Education 59 (2), 661–686 (2013). DOI: 10.1016/j.compedu.2012.03.004
7. Deursen, A., Dijk, J. van: Ctrl Alt Delete: productiviteitsverlies door ICT-problemen en ontoereikende digitale vaardigheden op het werk. Twente University, Enschede (2012).
8. Schönfeld, C.L.: Hoe IT projecten slagen en falen – Leren van pijnlijke ervaringen. Academic Service, Den Haag (2012)
9. O'Connor, J.: Creativity, Culture and Education. Arts Council England, Newcastle upon Tyne (2010). Retrieved from http://www.creativityculture education.org/wp-content/uploads/CCE-lit-review-creative-cultural-industries-257.pdf
10. Caves, R.E.: Creative Industries: Contracts between Art and Commerce. Harvard University Press, Boston (2000)
11. TSB (2013) Creative industries Strategy 2013-2016. Swindon: Technology Strategy Board. Retrieved from www.innovateuk.org
12. Potts, J., Cunningham, S.: Four models of the creative industries, International Journal of Cultural Policy 1201(1), 163-180 (2008). DOI: 10.1080/10286630802281780
13. Nonaka, I.: The knowledge-creating company. Harvard business review, 69(6), 96-104 (1991)
14. Norman, G.: Likert scales, levels of measurement and the ''laws'' of statistics. Advances in Health and Science Education 15(5), 625-632 (2010). DOI 10.1007/s10459-010-9222-y
15. Global Game Jam 2015, http://globalgamejam.org/news/ggj-2015-official-stats
16. Redmonk programming languages rankings 2015, http://redmonk.com/sogrady/2015/01/14/language-rankings-1-15/
17. Kirschner, P.A., Sweller, J., Clark, R.E.: Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching. Educational Psychologist 41(2), 75–86 (2006)
18. Westera, W.: Games are motivating, aren´t they? Disputing the arguments for digital game-based learning. International Journal of Serious Games (2015). Online publication at http://journal.seriousgamessociety.org