Adaptive Serious Gaming for the Online Assessment of 21st Century Skills in Talent Selection

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***Abstract*— 21st century skills are key factors sought by organizations in the 4th Industrial Revolution. Our objectives are twofold: 1) To test the use of serious games for detecting the 21st century skills among highly qualified personnel (HQP); and 2) To develop an adaptive and gamified system for boosting skill acquisition and for talent selection of HQP candidates. The main findings represent a first encouraging step towards measuring skill proficiency through serious gaming which in turn could serve to trigger personalized content and interactivity.**

Keywords-serious gaming; cognition; non-technical skills; human resources; talent selection.

I. INTRODUCTION

The number of ways interactive games can be used is expanding beyond the traditional areas of entertainment and education. Serious games and gamified simulations are widely recognized for their potential to foster learning and the acquisition of non-technical skills. Serious games can be a very powerful tool for developing skills such as an analytical capacity for decision making. There is growing interest in making serious games adaptive – games that would adjust their content, storyline, difficulty level and feedbacks to the players' interactivity, preferences and fluctuating affective-cognitive state. We wish to present innovative ideas related to the use of such adaptive systems in talent selection. These ideas have emerged from an ongoing research endeavor concerned with the development of adaptive serious gaming and the capability to monitor human performance, behavior and functional state in near real-time. Adaptive games could boost the ability of serious games to contribute to the training and assessment of 21st century skills such as systemic thinking, creativity and cognitive flexibility. In the present project, one key objective is to establish whether adaptiveness could be based on the monitoring of indicators of skill acquisition and mastery. We seek to identify a set of gaming behaviors and measures of the functional state that can provide an assessment of the ability to think in a critical manner, to be creative and to be flexible in making decisions.

Personnel selection is based on the use of traditional tools (e.g. interviews and questionnaires) to assess the suitability of a candidate for one position. Among highly qualified personnel (HQP), the 21st century skills – systemic thinking, adaptability and creative problem solving – are key factors sought by organizations in the era of the 4th Industrial Revolution [12][8]. While the selection interview – including the semi-structured job-oriented interview – and psychometric testing represent the most common ways organizations use to determine the best candidate to fill out a position, the shortcomings raised by several authors (e.g. traditional tools are not adequate to assess whether the candidate holds one or more 21st century skills – see [13]) denote the importance of reviewing how to carry out the selection process by using new tools such as serious games [2]. Considering that a large number of organizations worldwide are using at least one serious game as a training tool, it is relevant that research now focus on serious games as a way to select candidates as opposed to conventional staffing methods [1]. In the present project, we wish to use serious games in order to detect the 21st century skills among HQP and develop an adaptive and gamified system for talent selection and assessment of HQP candidates.

II. MEASUREMENT

In order to provide an assessment capability, a game should be capable of capturing a variety of in-game user behaviors such as "information seeking", "making a decision", or "reviewing alternatives", as well as the context in which those behaviors occur within the game [5]. It should capture context at a high level, such as the level of difficulty, the level of stress that the user is under [6], or the number of decision constraints the user is facing [4]. The focus should also be on measuring changes in performance and skill indicators under different conditions (e.g., high/low time pressure) and over time (e.g., track progress). The choice of human performance measures depends in part on the importance of the underlying skill in the context of a specific scenario. For cognitive dimensions such as information seeking and the management of workload, systems that track head and eye movements can provide unobtrusive information about the current locus of visual fixation that enables inferences about the locus of attention [10]. Eye-tracking data can provide a large range of metrics that can be very informative about dynamic decision making. For instance, scanpath measures – which relate to saccade-fixation-saccade sequences of eye movements – can index the efficacy in information seeking, while fixation metrics,

 ISBN: 978-1-61208-706-1

which measure how long the gaze is relatively stationary, can help estimate the processing (or encoding) time [11]. Combinations of behavioral measures can also provide information about time-sharing and multitask performance. A key dimension of the measurement – psychometrics at the basis of the skill assessment – is to operationalize each skill in measurable indicators imbedded within the game [5].

III. PRELIMINARY STUDY

As an initial step towards the development of the adaptive serious gaming approach to non-technical skill assessment, we designed a study looking at the convergent validity. In this section, the method and the preliminary results of the study are described.

A. Method

Ten participants were candidates going through the selection process of a small high-tech company. All had engineering, AI or computing backgrounds. Participants first played four times 12 rounds of the game Democracy 3. In this game, the player is a head of government, must manage state affairs and the end goal is to be re-elected. Democracy 3 portrays complex decision-making and requires systemic thinking, creative problem solving and cognitive flexibility (see [3]). Each game test was followed by a subjective assessment of skill acquisition (self-report and observer ratings on a scale of 1 to 10). Order of tasks was counter-balanced – across self and peer assessment, each skill to be assessed and playing Democracy 3.

B. Results

Performance scores were calculated as a product of re-election polls and financial budget. 60% of the participants managed to be re-elected with an average poll of 52%. Performance scores proved to be sensitive to individual differences. There was little relation between the results associated to the assessment of the skills and those associated with playing Democracy 3. Interestingly, overall, re-elected participants seem to show greater skill assessment – save for the self-reporting of adaptability (see Table I).

TABLE I.

	Re-elected	Not Re-elected
Nb	6	4
Average Poll	52%	6%
Adaptability Self	0.70	0.88
Adaptability Peers	0.73	0.69
Creative Self	0.76	0.60
Creative Peers	0.80	0.71
Systemic Self	0.86	0.70
Systemic Peers	0.75	0.72

The delta between the self-assessment questionnaires and the peer assessment varies considerably across participants (see Table II). Our findings represent a first encouraging step towards measuring skill proficiency through serious gaming which in turn could serve to trigger personalized content and interactivity.

TABLE II.

	Mean	Standard Deviation
Adaptability Self	0.76	0.19
Adaptability Peers	0.72	0.10
Creative Self	0.71	0.23
Creative Peers	0.77	0.09
Systemic thinking Self	0.87	0.10
Systemic Thinking Peers	0.74	0.11

IV. ARCHITECTURE OF THE ADAPTIVENESS

The components of the adaptive system would be comprised of modules for content delivery, online assessment of skills and for directing adaptation. The purpose of the content delivery module is to present the game and tests content to the candidate [7]. This is the component of the system with which the candidate (player) interacts. The presentation of the game content is controlled by the adaptation module. The delivery module must report outcomes and user interactions as required by the evaluation module. The purpose of the evaluation module is to update the model or assessment profile of the candidate based on measurements of the candidate. In the case of a first assessment through the system, the model of the candidate does not contain any data besides initial self-reports. The evaluation module should be capable of direct measurements using eye tracking, physiological and "face reading" devices, as well as indirect monitoring of performance from user interactions reported by the content delivery module, such as key presses, decision accuracy, timings, quiz results, and so on. The purpose of the adaptation module is to adapt the delivery of content based on the evolution of the candidate model (profile). The adaptation module must examine the difference between the candidate's performance and skill evaluation with the expectations and desired skill profile of potential employers. Mechanisms of adaptation may include: adapting the pace of information delivery; adapting the complexity of the game; altering the assessment content and objects that are presented.

V. CONCLUSION

Initial results are promising in validating the assumption according to which performance at playing Democracy 3 is related to other means of assessing non-technical skills. The recommended architecture would be the foundation of the adaptive serious game for the assessment of non-technical skills. Such a customizable system that takes into account inputs from potential employers and focuses its assessment on skill proficiency and attitude rather than expert

 ISBN: 978-1-61208-706-1

knowledge will greatly contribute to improve the efficiency and user-friendliness of the talent selection process.

ACKNOWLEDGMENT

The authors would like to thank B. Bussière, S. Savage and E. Guillemette for their contribution to the empirical work and to G. Foin for proofreading. This work was funded by the Social Sciences and Humanities Research Council of Canada (SSHRC).

REFERENCES

[1] M. B. Armstrong, R. N. Landers and A. B. Collmus, "Gamifying Recruitment, Selection, Training, and Performance Management: Game-Thinking in Human Resource Management", in Handbook of Research Trends in Gamification, H. Gangadharbatla and D. Z. Davis Eds. Pennsylvanie, PE: IGI Global, pp.140-165, january 2016.

[2] M. Fetzer, "Serious Games for Talent Selection and Development", The Industrial-Organizational Psychologist, vol. 52, pp.117-125, january 2015.

[3] D. Lafond, J-F. Gagnon, S. Pronovost, M. Ducharme and S. Tremblay, "Behavioral test for prediction of individual differences in dynamic decision making ability," Proceedings of the 7th International Conference of AHFE, Orlando, CA, july 2016.

[4] D. Lafond, B. R. Vallières, F. Vachon and S. Tremblay, "Judgment analysis in a dynamic multitask environment: Capturing non-linear policies using decision trees," Journal of Cognitive Engineering and Decision Making, vol. 11, pp.122-135, 2017.

[5] C. S. Loh and Y. Sheng, Y. "Measuring expert-performance for Serious Games Analytics: From data to insights," in Serious Games Analytics: Methodologies for Performance Measurement, Assessment, and Improvement, C. S. Loh, Y. Sheng and D. Ifenthaler, Eds. New York, NY: Springer, pp.101-134, 2015.

[6] M. Parent, J.-F. Gagnon, T. H. Falk and S. Tremblay, "Modeling the operator functional state for emergency response management," Proceedings of the 13th International Conference on Information Systems for Crisis Response and Management (ISCRAM). Rio de Janeiro, Brazil, may 2016.

[7] M. Peeters, K. Van Den Bosch, J-J. C. Meyer and M. A. Neerincx, "Situated cognitive engineering: The requirements and design of directed scenario-based training," Proceedings of the 5th International Conference on ACHI, Valencia, Spain, pp.1-8, 2012.

[8] M. Romero, M. Usart and M. OTT, "Can Serious Games Contribute to Developing and Sustaining 21st Century Skills? ," Games and Culture, vol. 10, pp.148-177, 2015.

[9] H. A. Spires, "21st Century Skills and Serious Games: Preparing the N Generation," in Serious Educational Games: From Theory to Practice, L. A. Annetta, Eds. Rotterdam, The NetherlandsArticle in a journal, pp.13–23, january 2008.

[10] S. Tremblay, D. Lafond, C. Chamberland, H. M. Hodgetts and F. Vachon, "Gaze-aware cognitive assistant for multiscreen surveillance," in Advances in Intelligent Systems and Computing, vol. 722. Intelligent Human Systems Integration, W. Karwowski and T. Ahram, Eds. Basel, Suisse: Springer International Publishing AG, pp. 230-236, 2018.

[11] F. Vachon and S. Tremblay, "What eye tracking can reveal about dynamic decision-making," in Advances in Cognitive Engineering and Neuroergonomics, K. Stanney and K. S. Hale, Eds. Boca Raton, FL: CRC Press, pp. 157-165, 2014.

[12] E. van Laar, A. J. van Deursen, J. A. van Dijk, J. de Haan, "The relation between 21st-century skills and digital skills: A systematic literature review", in Computers in Human Behavior, vol.72, pp.577-588, march 2017.

[13] J. VOOGT and N. P. Roblin, "A comparative analysis of international frameworks for 21st century competences: Implications for national curriculum policies," Journal of Curriculum Studies, vol. 44, pp.299–321, 2011.

 ISBN: 978-1-61208-706-1