Abstract

To successfully manage real-world complex problems that threaten our wellbeing, it is necessary to learn complex problem-solving (CPS) capabilities. Engagement in CPS processes can be promoted only in specific learning environments that simulate the uncertainty, unpredictability and uncontrollability of dynamic complex systems. Games can function as CPS learning environments because of their potential to (a) simulate authentic CPS dynamics in realistic complex situations, (b) promote cognitive, behavioural and affective holistic engagement of learners in game-based learning (GBL) processes, and (c) contribute to the acquisition, development, and improvement of CPS knowledge, skills, and attitudes. However, researchers and practitioners lack the appropriate tools to analyse and design gameplay features that may promote CPS processes in GBL environments.

Therefore, the aim of this thesis is to develop a set of complementary research tools that can support game experts to identify specific gameplay features of CPS scenarios that can be configured to promote intrinsically motivating GBL processes and cognitive CPS capabilities. Consequently, four research objectives were formulated, each guided by three research questions, that involve the development of instruments supported by conceptual models.

First, an analysis instrument was developed to support the identification of (a) simulated gameplay aspects of real-world CPS scenarios, and (b) key properties and functionalities of gameplay information flows that support player engagement with those gameplay aspects (i.e., the CPS-IF instrument, underpinned by the CPS-IF conceptual model). Then, an instrument was elaborated for identifying gameplay features that can make CPS processes in GBL environments intrinsically motivating to players (i.e., the CPS-GBL instrument, underpinned by the CPS-GBL conceptual model). Next, an analysis instrument was developed suitable to identify specific gameplay features that may promote required cognitive CPS conditions (i.e., the

GEFF-CPSC instrument, underpinned by the GEFF-CPSC conceptual model). Finally, guidelines were operationalised for configuring gameplay features to promote player engagement and cognitive CPS capabilities (the ability to engage in the uncertainty management process) (i.e., the CPS-GFC guidelines, based on the results of a systematic review).

The rigorous instrument development processes, the supporting conceptual models, the comprehensive systematic review method, and the results of the exploratory evaluation of the instruments, suggest that the produced instruments and models can be useful tools for game researchers and practitioners who are interested in (a) analysing or designing gameplay features that may promote CPS processes, (b) creating new research tools that are suitable to measure the effectiveness of games to foster CPS capabilities, and (c) generating new theories about how games can function as CPS learning environments.

Based on these contributions to research and practice and based on the key limitations of the thesis (i.e., (a) the exploratory nature of the validation tests and reliability assessments, involving low number of reviewers and games, and (b) the untested assumptions of the conceptual models for the effectiveness of games to promote CPS capabilities) the following directions for future work are suggested. Future research should involve more participants and diverse games for testing the instruments, and should integrate the instruments in a complementary way to explore the assumed potential of games to effectively promote CPS.

In conclusion, the thesis contributes to the research and practice of game design and analysis by providing research tools suitable for the identification of gameplay features that may promote player engagement in intrinsically motivating CPS and GBL processes. This study is one step on the path towards effectively analysing and designing games that may promote CPS capabilities through GBL.