ORIGINAL RESEARCH ARTICLE

Does the Resilience learning game facilitate open innovation and global citizenship reflecting sustainability in Greek IT and Telecom industry?

Eleni G. Makri

Faculty of Business, Old International Airport, Unicaf, Larnaca 7130, Cyprus; eleni.g.makri@gmail.com

ABSTRACT

Multimedia learning and development depicts a long-standing challenge for immersive design and regenerative learning in education and industry. Contradictory findings for gaming learning outreach in relation to conventional learning mode seem to turn the learning gameplay challenge into an enduring one. Limited research outcomes exist not only for open innovation (inflow and outflow innovation aspects) but also for global citizenship reflecting sustainability in education and learning game technology, in particular. Therefore, this study rests on exploring open innovation and global citizenship attributes reflecting sustainability in traditional and learning gameplay modes within an IT and Telecom industry setting. We report on 59 Greek employees' open innovation and global citizenship knowledge, attitudes and skills investigated after-workshop and after-Resilience gaming training in 2023. The attendees perceived the game as more constructive learning and development tool for open innovation and global citizenship capacity compared to conventional learning delivery. Open innovation was connected to aspects of global citizenship (diversity, interpersonal and problem-solving, and seeking knowledge about political/societal issues) that reflect sustainability post-Resilience gaming. Legal male gender and Athens municipality origin were associated with higher open innovation and diversity (element of global citizenship) attributes post-Resilience gameplay. The obtained evidence is discussed alongside theoretical and practical reflection and strands for additional research in learning game open innovation and global citizenship (sustainability) outreach in education and industry.

Keywords: learning games; open innovation; global citizenship; sustainability; IT and Telecom industry; Greece

1. Introduction

Learning games seem to bear an emerging innovative and immersive learning and development approach in education and industry. In the long effort to improve inclusive, innovative and edutainment attributes learning and development in higher education interdisciplinary curricula and intersectoral industry training, learning games are designed (co-developed/open innovation) and continue to emerge as open innovation advanced technology tools. Allowing multiple users to be "absorbed" by completing learning game activities successfully in a self-directed in-game networked gameplay environment that uses diverse technologies to simulate real-world challenges (e.g., VR/AR/MR, sensor technology) that need to be addressed. The use of learning games has recently risen across cross-over fields following rapid social, economic, and technological challenges and is supported by the call to promote community/public-based adjustment[1]. Indicative examples of these domains among others reflect business, entrepreneurship, STEM and medical education, architecture, urban design and planning, peace,

humanitarian and physical education, health psychology, supply chain management, circular economy, biochemistry, and moving to environmental sustainability and resilience, citizen and open science, recently. Empirical findings regarding the assessment of learning games and conventional learning delivery tend to have achieved either a rather inconsistent account of learning performance across different learner cohorts and subject areas[2] or not a full all-encompassing procedure in gaming design for certain topics (e.g., disaster management process: pre-, during-and post-disaster awareness, attitudes and skills[3]. In addition, learning game research that relates to open innovation-associated knowledge and practice and global citizenship (global civic) attributes exercise, is rather limited in growth. Along this line, the present paper aims to feature the research executed as part of workshop training in open innovation and global citizenship in an IT and Telecom industry in Greece. Investigating open innovation and inclusive citizenship knowledge, attitudes and skills continuum during conventional workshop and learning game instruction (or learning and development) in 2023. 59 employees were examined on the extent of their open innovation and global citizenship account after-workshop and after-learning gameplay training, as means to foster positive open innovation and inclusive citizenship mentoring through learning gaming and vice versa. Following the aforementioned reasoning, thus, the study questions that align with the rationale and scope of the present research, are as next:

- Do employees exhibit different levels of open innovation and global citizenship-related attributes post-workshop and post-learning gaming?
- Are there any significant relationships indicated between open innovation and global citizenship-associated attributes for employees after-gameplay?
- Are any important differences reported in open innovation and global citizenship-linked knowledge, attitudes and skills by employees based on legal gender (male vs female) and municipality origin (Athens vs. other) post-gaming?

The remainder of the present paper is organized, as next. Section 2 reports learning game open innovation and global citizenship/sustainability-related research cross-culturally. Section 3 elaborates on a short game description, research methodology and measurements. Section 4 presents the empirical findings analysis. Section 5 summarizes the results, their outreach in terms of the open innovation and global citizenship/sustainability-related continuum and outlines the conceptual model obtained by the study evidence. Section 6 concludes this paper with future research routes for learning game teaching and learning.

2. Related work

The following literature review presents a comprehensive account of the limited yet growing open innovation- and- global citizenship/global civic attributes- interdisciplinary learning game research in diverse adult learner contexts. Yap et al.[4] elaborate on their co-designed learning game "Retrozfect" (or RZT). The game targets public health university students by aiming to support their learning on pharmacotherapy-related knowledge and attributes following a systems dynamic modelling (open innovation). The players reported that they seemed to enjoy being assigned the role of pharmacist avatars across 5 diverse game scenarios hosted in an after-apocalyptic environment with zombies, with the mission to find a cure for the mankind by interacting with patients to advise on the right medication that should be received and prepared in a self-selected adventure mode. Once they finished different game activities along each of the 5 scenarios by killing the zombies, a pharmacy was released, with the players needed to work collaboratively in-teams to extract appropriate drug advice from in-game resources. Diverse rewards and scoring items were further introduced during gameplay (plot animations, feedback, item grants, player tracking system, etc.). 30 pharmacy undergraduate students (19–24 years old) were recruited by snowballing method to take part in the study and divided into teams of 6. They played the game after their final assessment at their professional development (counselling) hub labs in their university in Singapore, Thailand. The attendees were required to complete pre-and-post pharmacotherapy quizzes. After their gaming session, they were requested to answer the same items post-

gaming quiz. Quizzes scores were compared to disclose any revealed differences. Oculus rift was used to experience one game scenario of the 5 overall practiced. At the end, the learners completed 25 items reflecting demographics, gaming interests and frequency of gaming in the past 6 months. Items also gathered players' answers on their gaming practice, the game's mechanics and interface and support in pharmacotherapy curriculum teaching and learning. The participants agreed that leap motion (90%) and oculus rift (80%) added on to the overall immersive experience. 76.7% would prefer to play the game in a self-formed group, with 60% of them enjoyed playing the game regardless of whether being in a self-formed or pre-assigned group. 93.3% could communicate well with their team mates, 100% enjoyed playing with their team mates, 96.7% would like more scenarios of the game to be multiplayer. 76.7% perceived that the avatars appealed to them, with 80% of them indicating that there was an appropriate variety of avatars to select from. 96.7% reported that there was enough time to complete the game activities, 80% perceived enjoyable and game-engaging to be able to kill zombies during gameplay. 63.3% of the students indicated that they would like to see the game integrated into the pharmacy practice curriculum. 60% of the learners would prefer the game to complement lecture, 90% reported that the game could supplement in-person counselling, 73% would like the game embedded into the curriculum sessions, with 13.3% recommending that it could also be implemented as additional assessment tool. 80% perceived the interaction with the avatar(s) helpful in patient history evaluation, health record obtained and sufficiency of the recommended medication. 90% of the students reported the game as fine practice for prescription delivery. 73.3% welcomed the debriefing after gaming for further understanding the learning goals of the game. 63.3% had played games in the past 6 months. 56.7% indicated that the leap motion device was easy to use, with 83.3% of them reporting that it was easier to use it over time. 46.7% reported feeling uncomfortable with using the oculus rift, although 80% of them perceiving it to support their immersive gaming experience. 96.7% of the students recommended more multiplayer gameplay scenarios, with 76.7% preferring to create a team gaming group by themselves. 53.3% found the game objectives comprehensive, with 56.7% reporting that they would agree to play the game more than once. The learners enjoyed the cooperative (i.e., team) and negotiating nature of the resolving challenges game mechanics, and further indicated higher scores in competence, sensory and imaginative immersion, flow and positive affect game experience indicators assessment.

Short[5] reports on her introduction of a learning game assessment into the operations management curriculum in Irish higher education. The game aimed to instruct students on diverse systems design modelling of supply chain management process (i.e., generating, designing, operating, screening and improving/open innovation) ending up to successful production and delivery of clothing manufacturing and distribution goods. The author had researched and piloted the practice of the game during prior year at the institution. In the present year, she chose to embed it into the corresponding module's structure hoping to sustain a helpful, experiential, and immersive teaching and learning practice for the 135 students registered to 2 business and 1 engineering courses, respectively. The players are introduced to a number of different production-related scenarios (covering the following 5-modules: production, supply chain, forecasting, human resource management, capacity development) under the role of an operations manager. The learning game challenges start from module 1 where the player can seek advice on how best to complete the tasks to module 5 where the resources toolkit is suspended and the user has to set up and run his/her own manufacturing space. At first, it was expected to employ the game as part of the learners' ongoing assessment (50% of the final mark), with theory assessment included in the final exam (the rest 50%). Shared discussions with the students ended up with using the game instead as the main content for the operations management module. The students, therefore, were advised to use the game and the supplementary manual as their principal content resource. They were free to improve it with other material created by themselves in an additional self-directed learning approach. After completing each game turn, the players are introduced to a theory question to answer (reflecting a non-graded formative evaluation). Student feedback disclosed that they preferred to search for these questions on Google, as means to co-design their own learning activities in order to master their subject knowledge and therefore, improve

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their self-directed learning further. The game awards the learners with different scores (target accomplished: 10%; net worth: 50%; reputation: 20%, timeliness: 20%) that can be modified by the lecturer(s). The latter are also able to change the number of game turns in each module (each turn reflects a week of production) as well as the number of attempts that can be applied. Graded written reflection assessment was required to be filled in and uploaded on the VLE by the students after completing each module. The participants had also to indicate their module scores and the attempts they took, supporting their reflection feedback further. Student feedback within each module became gradually more detailed, comprehensive and reflective especially with repeated attempts to master module 4 (human resource management) which deemed to be the most challenging one (as perceived by both learners and tutor). Notwithstanding the usefulness of this extended personalized reflective in-game assessment feedback offered, this kind of feedback obtained from such a large number of learners seems rather very time consuming to be sustained. Nevertheless, the author recommends lower frequency of reflective feedback assessments provided per game module to foster feedback sustainability. Overall, most participants reported edutainment by playing the game, while others indicated anxiety about delivering game orders on time. The students seemed to experience immersion (time passed by without being aware of being into the game). They perceived themselves as being operations managers, with shared discussions about the game followed between them and with their family, and feelings of accomplishment resting on resilience in completing the game challenges per module turn. Other peers reported that the game reflection assessments introduced them to alternative enjoyable exercises, watching on the game's interface what you do and how things are progressing.

Poonnawat et al.[6] present the co-design and assessment of their learning game "Business Intelligence". The game was a co-development activity between the Stuttgart Media University and the University of the West of Scotland. The target was to address the challenge of business intelligence (open innovation) and 21st century skills improved teaching and learning at higher education. The game was introduced in 2014 and assessed by learners at different EU tertiary education institutions. The students are assigned the role of in-game generation, implementation, and assessment of their launched business plan. As in-game protagonists, they have to take decisions, analyse data and information, perform cost analysis and reflect on their decision making assessed for further development in their following decisions. The in-gaming organization stands for a successful enterprise that sells high-tech bicycles and accessories. It is a company intended to expand nation-wide. The in-gameplay includes 4 layers: introduction, business indicators, data gathering, and modification. During introduction and business parameter levels, the students need to create and deliver their business plan by placing the preliminary business indicators. In the third level, the business parameters and the dealings for business events performed are composed. The last level includes the simulation of data and information and their storage in a company data warehouse. Then, the players are assigned with their business intelligence learning tasks. The first business intelligence learning task is the "build business intelligence" module (including multi-dimensional modelling and enterprise design and procedure parts). The business intelligence module aims to support students preparing and delivering analytical data. The other modules include sales analysis, business planning parts, various business scenarios with learners performing business analysis and modify their indicators. Next, they execute the data analysis with results compared to the refined business parameters for next steps. The Business Intelligence game introduces players to a particular bike market context. Next, the gamers are assigned to groups of 3 to 4. Each group is allocated to a city with the mission to open a new bike store in the region. The in-game city includes approximately 250.000 inhabitants. Each student group represents a management team that runs the bike store. The group members have to obtain all market profile information, bike store competitors, etc. They need to create their shared business plan taking into account location, target team, competitors list, production, sales and marketing, human resources, and finance. The in-game moderator serves as an enterprise executive that allocates preliminary market share reflecting the quality of the recommended business plan. Next, the learners enroll at the business intelligence game and configure their introductory business indicators. They allocate a store to rent, order bikes from the

stock, select personnel and sales and marketing plans. They can also integrate additional stores in-game, request new products and (or) develop new marketing moves. Success business parameters include location, products aligning with demands, trained workforce, effective marketing, real-world weather condition and related sport events. In that respect, the authors expect that the business intelligence game will assist the students to improve their analytical, information technology, and business and communication attributes further (i.e., 21st century skills). 16 students used the prototyping of the business intelligence game with some prior background in business intelligence-associated attributes. They were required to fill in a pre-gaming self-assessment and a traditional lecture mode assessment (i.e., demographics, 21st century and business intelligence-related skills). Previous corresponding module assessments data were also collected. Likewise, they were requested to complete a post-gaming and (or) conventional lecture module self-assessment, respectively. The preliminary findings indicated that 55%–60% of the students seemed to bear high to moderate 21st century skills. 19% of the participants assessed themselves in having high level of creativity, with 13% of their peers managing uncertainty. 80%–85% of the learners did evaluate themselves as having moderate to low business intelligence attributes. As regards the enterprise teaching and learning skills procedures, data mining, and social business intelligence notions, no student assessed himself/herself as having high corresponding attributes. Notwithstanding the high to moderate 21st century skills, business intelligence skills seem to be developed hopefully through the business intelligence learning game. Post-gaming self-assessments, no learner tended to appraise himself/herself as having decreased business intelligence skills. 67% of the students assessed themselves with high level business intelligence attributes, with 60% and 80% of their peers as having high level of business planning and multidimensional modelling skills, 73% and 60% of them bearing high enterprise teaching and learning procedure and data mining skills. Overall, 67% of the participants did seem to learn more with the business intelligence learning game. The authors indicate that the business learning game is currently under further development with a view to include more business intelligence learning activities: data mining, analysis, and scorecard dashboard to increase the depth of the business intelligence learning.

Chee et al.[7] introduce their co-designed learning game "Space Station Leonis" assessment performed by 42 pre-college students in Singapore. The game aimed to instruct learners on citizenship education-associated aspects. It was integrated into the innovative citizenship learning course that includes 9 lesson plans of 2 h each embedding also learning material, activities, and formative and summative assessments supported by wiki. The game was a co-development effort inspired by the Learning Sciences Lab of the National Institute of Education, Nanyang Technological University, Singapore. It includes 7 game sessions with the players assigned the leading roles. It is a single player Windows PC game. In game sessions 2 and 3, the players are able to select between 2 leading roles available. The game reflects a science fiction adventure. The gameplay is set up in the 23rd century, with humans in Earth having populated the Moon, Mars and other planets of our terrestrial system. Leonis depicts the space station that moves around Earth. The Leonis residents are expatriates from Earth, the Moon and the Mars planets. Without plenty of natural resources, the sustainability of Leonis seems a great challenge to address. Working together effectively with the cross-cultural inhabitants tends to be impactful for Leonis' current and future survival. Across the 7 gaming sessions, the learners have to address diverse challenges that reflect sensitive issues pertaining to national identity and (or) religious beliefs, as next. In session 2, should the players follow the government's objectives/regulation or take part in a petition against the government's dictate to preserve their right to be dressed with their native costume at a parade? In session 3, the players are assigned the role of the president of Leonis. They have to address the challenges of providing inhabitants with housing, education, healthcare and defense support, and also handle international relations, financial costs, and terrorist attacks to support successfully the context-specific and overall safety and prosperity of the Leonis' population. Cooperation with others, empathy for civic issues, civic responsibility and action for diversity and inclusion improvement taking into consideration environmental sustainability and resilience tend to denote the overall sustainability-related gaming target. The

authors preliminary result gameplay assessment revealed that Space Station Leonis seemed to be related to a) advanced perception of working together with others for shared effective challenge solutions, b) greater inclination to realize the impact of individual decisions on others' lives, c) higher insight that society and the world is a cross-cultural and ethnic fusion and that we all need to be more conscious and empathetic about others' problems, d) advanced willingness towards peaceful co-existence with others, e) greater win-win negotiation and conflict management disposition, f) enhanced insight on self-control, self-responsibility and acceptance of individual choice impact, g) higher inclination for environmental sustainability and resilience, and engagement in political process, and h) greater interest in community issues against individual ones. Overall, the authors seem to suggest that the Space Station Leonis game tends to bear preliminary promising evidence for improving students' perceptions of "being citizens" to iteratively "becoming citizens". In the aforementioned studies, it seems that the co-designed intersectoral learning games share, by and large, various facets of and encouraging evidence on open innovation and global citizenship reflecting sustainability.

3. Material and methods

3.1. Game description

The Resilience awarded learning game depicts a co-designed tool that was co-created by a shared inflow and outflow innovation networks in the USA. Undergraduate students from diverse subject areas, their supervisors, higher education centres, and professionals involved in humanitarian support shared their knowledge and expertise in co-developing this game. The target of this networked and "engaged" effort[8] is to trigger and form community and public engagement in sustainable refugee endurance[9]. This game reflects an immersive exercise of global (universal/inclusive/large-scale) citizenship (civic attributes), as users "become part of global challenges and solutions on shared values and inclusion"[10] to complete the game effectively. The learners (employees) are "appointed" as migrant campground supervisors on an outer space planet. Across all game levels and connected activities (tasks), they have to deal with and successfully settle emerging challenges. These challenges adhere to unknown inhabitants from other planets marching into their camp planet, putting the safety, autonomy, and sustainability of the camp members at risk. In order to address the above risky situation effectively, the gamers need to adopt and implement actions that reflect open innovation and global citizenship/global civic attributes: among others, offer of all accessible inbound and outbound resource toolkits, risk sharing, awareness and adaptation of migrant requests and inclinations (learning about the community, active membership, help others in need, committed to making a positive difference, resolving conflicts, thinking logically, placing themselves in the place of others, awareness of community issues, leading others, sense of making a difference in the world, changing people's attitudes to solve social challenges, equal opportunities to be available to all, interacting with people from a different cultural/race background), etc. As usual in learning game development, the game follows a systems design thinking[11] by attempting to cover multiple intersectoral aspects of migrant campground sustainability and networked agency and capacity building. Evident in the game mechanics and user interface, where the migrant camp director interacts with diverse inflow and outflow agents and leads the camp on a device. The game "actors", the visuals, the geometrical shapes in the campground, the structures, the nature around the buildings, even the device that the camp supervisor uses to manage the operation of the camp, are envisaged as "images" of real-world migrant life transferred to in a science fiction gaming space. **Figure 1** below illustrates an indicative screenshot of the Resilience learning game depicting the camp's sepulture place.

Figure 1. Screenshot of the Resilience learning game burial place.

3.2. Study design

59 full time employees of an IT and Telecom organization in Athens, Greece, participated in the current study as part of their onsite 3-hour workshop in open innovation and global citizenship. The aim of the survey was to explore and assess the employee's attributes of open innovation and global citizenship after-workshop (traditional learning route) and after-Resilience gameplay (immersive learning strand), accordingly. Following discrepant findings that compare traditional to multimodal learning modes[2] and restricted learning game development for open innovation and global citizenship-related nexus[12], to explore whether Resilience gaming seems to support more positive open innovation and global citizenship agency and capacity when compared to conventional learning, accordingly. All registered employees offered their informed consent form to attend the survey after receiving a comprehensive information sheet reporting the target of the research using their data. **Figure 2** below outlines a flow diagram of the study.
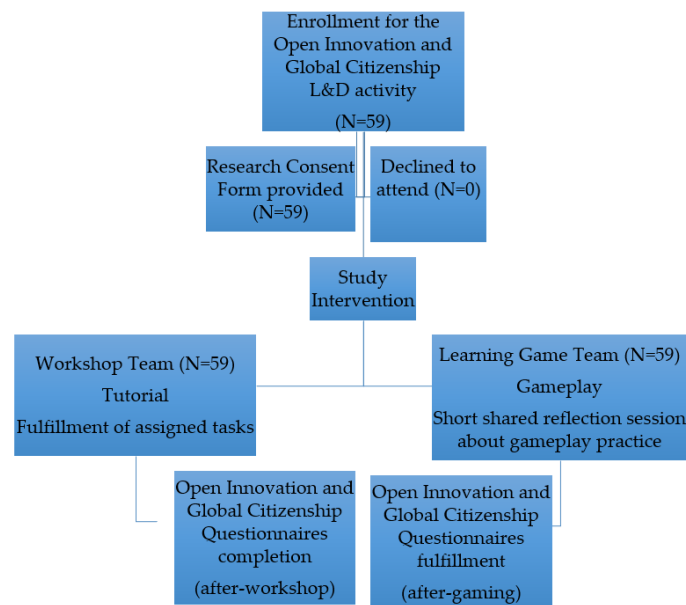

Figure 2. Flow diagram of the survey.

Post-consent form provided, the participants were first required to fill in demographics (i.e., gender, department/division, job role, work status, residency and enrollment to vote in elections items). Next, they attended a 50-minute workshop that involved open innovation and global citizenship-related learning tasks. Subsequently, they completed a) a 47 open innovation-oriented self-assessment[13] modified for the needs of the present study to evaluate issues of open innovation-associated reflection and attributes practised in their organization, and b) the civic attitudes and skills self-assessment[14] reflecting global citizenship (global civic) challenges. The open innovation self-assessment included the following attributes mirroring attendees' organization: a) exercise of open innovation and open innovation-connected notions, b) appreciation in using as part of open innovation process, c) insight in applying open innovation, d) sense in using to instruct open

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innovation, e) sense in applying for success of open innovation procedure, f) regard for implementing as source of information for inbound innovation, and g) eagerness to use as source of information for outbound innovation, post-Resilience learning game. All items introduced a 5-point Likert response mode based on how often the particular relate to the attendees (1 = never to 5 = always) and high consistency reliability (i.e., 0.82). The civic self-assessment consisted of the following attributes reflecting participants' company: a) civic action (i.e., engagement in volunteering, community action, cleaning up the environment), b) interpersonal and problem-solving skills (i.e., conflict/challenge resolution, logical problem-solving, shared and effective communication, placing oneself in the position of others), c) political awareness (i.e., awareness of local, community and global issues), d) leadership skills (i.e., lead groups and make a difference in the world), e) social justice (i.e., change public policy, understand the reasons for individual, group, community and society misfortunes, need for attitude change for greater social good, equal opportunities to all), f) diversity attitudes (i.e., liaise and work with people from diverse background, cross-cultural diversity in groups supports successful group functioning), and g) seeks knowledge about political/societal issues (i.e., follow updates on city, community and wider political issues). The aforementioned civic self-assessment reflects a global (universal/inclusive/large-scale) citizenship (civic) attribute orientation/adaptation/measurement (i.e., engagement in issues facing the world, the nation, the community, the city, the environment, changing public policy to inform equal chances to all, fostering individual development/competence building, etc.) that mirrors "a universalizing vision of the world"[10] and articulates the following global citizenship typologies by Pashby et al.[10]: a) neoliberal (knowledge society, competence building, self-motivation, entrepreneurial), b) liberal (democratic values, shared respect and concern, cultural equality, civic processes that embed dialogue, universal notion of self, moral values and society), c) neoliberal-liberal interface (openness to others from other regions, engagement in cultural diversity and civic procedures that promote interaction and environmental issues), and d) liberal-critical interface (liberal as above; critical: acknowledge and address social injustice, involvement in environmental challenges). All items included a 5-point Likert response resting on agreement or disagreement with each question (1 = completely disagree to 5 = completely agree) and the scales demonstrated moderate to high a consistency reliabilities (i.e., 0.78 to 0.82). Items negatively worded for presentation were reverse coded before analyses were executed.

The participants answered both their open innovation and civic self-assessments based on their L&D experience with the workshop instruction (after-workshop). The second and third hour of the workshop session the moderator first introduced the participants to Resilience open innovation-connected learning game through a comprehensive demo. Attendees were advised to play the iterative interface game as long as they enjoyed either in pairs and (or) in small groups[15] around one hour. During and after-gaming the facilitator moderated shared reflections and debriefing across learners. The employees' post-Resilience gaming observation, insights and comments reported were favourable in terms of usability, learningtainment, and learning experience addressing the open innovation and global citizenship-learning nexus. The employees were guided to complete both the open innovation and global citizenship self-assessments post-gaming (post-gameplay).

3.3. Results

30 male and 29 female employees of an IT and Telecom organization in Athens ($N = 41$) and other municipality origin ($N = 18$) offered full open innovation and global citizenship/sustainability-associated accounts after-workshop and post-gameplay instruction, accordingly. To explore potential relationships between open innovation and global citizenship/sustainability-related attributes after-gaming among employees, the following analyses were performed: a) hierarchical regression analysis for the prediction of open innovation-oriented assessment by global citizenship/sustainability nexus after gameplay, illustrated in **Table 1** that follows next. Further, to assess possible differences in open innovation and global citizenship/sustainability-related attributes post-workshop and post-gameplay, paired samples t tests were additionally performed, as reported in the following **Table 2**. In addition, to explore likely differences in open

innovation and global citizenship/sustainability-associated nexus exhibited by the attendees post-gameplay, a 2 (legal gender: male vs. female) × 2 (municipality: Athens vs. other) between groups ANOVAs were additionally performed, as presented in **Tables 3** and **4** that follow next, respectively.

3.3.1. Hierarchical regression

Hierarchical regression analyses were executed to check the prediction of open innovation post-gaming for employees by global citizenship attributes post-gameplay. Before performing the analyses, we ensured that all required conditions related to regression (i.e., lack of multicollinearity, deviations from normality and influential cases) were addressed. Gender was employed as control variable supporting previous findings in open innovation and (or) global citizenship /sustainability-related research[14,16]. The evidence obtained from this analysis is reported in **Table 1** that follows next. At the first step we entered the control variable (i.e., gender) and then the independent variables (global citizenship/sustainability continuum: civic action, interpersonal and problem-solving skills, political awareness, leadership skills, social justice, diversity attitudes, and seeks knowledge to political/societal issues, respectively. The results illustrated in **Table 1**, reflect the outcomes of the final relationships indicated between the above scales. As regards after-gaming context, the associations between interpersonal and problem-solving skills, diversity attitudes and seeks knowledge about political/societal issues with open innovation were significant, indicating the first (i.e., interpersonal and problem-solving skills as the best predictor ($\beta = -0.59$, $p < 0.001$; $\beta = -0.32$, $p < 0.01$, $\beta = -0.27$, $p < 0.10$, accordingly). The final model including the corresponding variables accounted for an extra 5 percent ($F(8, 57) = 3.616$, $p < 0.01$) of the variance in open innovation interaction scores (**Table 1**).

Table 1. Hierarchical regression analysis for the effects of global citizenship/sustainability-related variables on open innovation after-gaming.

	Open innovation post-gameplay		
	β	R^2	ΔR^2
Step 1: Control variables	−0.11		
Gender			
Step 2: Main effects		0.37****	0.05****
Civic action	0.18		
Interpersonal and problem-solving skills	−0.59***		
Political awareness	−0.19		
Leadership skills	0.09		
Social justice	0.07		
Diversity attitudes	−0.32**		
Seeks knowledge about political/societal issues	−0.27****		

Notes: **$p < 0.01$ (one-tailed); ***$p < 0.001$ (one tailed); ****$p < 0.10$ (one-tailed).

3.3.2. Paired samples *t*-tests

The results presented in **Table 2** below indicate that there seem to be significant differences between all open innovation and global citizenship/sustainability-related nexus after-workshop and after-Resilience gameplay, as next. In terms of open innovation-orientation after gameplay, the attendees did demonstrate a) higher sense of frequency in exercising open innovation in their organization and awareness of open innovation-connected notions, b) greater appreciation as part of open innovation procedure in their organization, c) improved insight to instruct open innovation in their entity, d) greater perception regarding the impact of open innovation in their business, e) higher inclination to instigate as source of information for inflow innovation, and f) advanced keenness to apply as source of information for outflow innovation, after playing the Resilience learning game. As regards the global citizenship/sustainability-related attributes post-

gaming, the participants did indicate: a) enhanced intention to engage in volunteering, community work, cleaning up the environment, and commitment to making a favourable difference (civic action), b) greater sense of working with others effectively, implementing logical problem-solving, resolving conflicts/challenges, taking other perspectives into consideration or placing themselves in the place of others to reflect on their condition (interpersonal and problem-solving skills), c) higher inclination to know current local, community, region, nation-wide and global issues and involvement with political procedure (political awareness), d) greater sense of leading groups of people successfully and making a positive difference in the world (leadership skills), e) improved intention to alter public policy to effective problem-solving and offer equal opportunities to all people for effective inclusion (social justice), f) greater preference for cultural diversity during in-and-out group connections to increase interest and effectiveness (diversity attitudes), and g) higher insight to seek knowledge for and updates on current political and (or) societal issues around local, community, regional, society and global challenges (seeks knowledge about political/societal issues), respectively. In sum, therefore, the Resilience learning game tends to relate employees to both more open innovation-related attributes and global citizenship/sustainability-connected agency and capacity compared to traditional learning strand, accordingly.

Table 2. Paired samples T tests between open innovation and global citizenship attributes post-workshop and post-Resilience gameplay ($N = 59$).

Open innovation	Sig. (2-tailed)
Open innovation after workshop-open innovation after gameplay	t(58) = 3.94, $p < 0.001$***
Global citizenship/sustainability attributes	
Civic action post-workshop-civic action post-gaming	t(58) = 2.56, $p < 0.001$***
Interpersonal and problem-solving skills after-workshop-interpersonal and problem-solving skills after-gameplay	t(58) = 3.45, $p < 0.001$***
Political awareness post-workshop-political awareness-after gaming	t(58) = 2.90, $p < 0.001$***
Leadership skills after-workshop-leadership skills-after gameplay	t(57) = 2.54, $p < 0.05$*
Social justice post-workshop-social justice post-gaming	t(58) = 2.69, $p < 0.001$***
Diversity attitudes after-workshop-diversity attitudes after-gameplay	t(58) = 3.45, $p < 0.001$***
Seeeks knoweldge about political/societal issues post-workshop-seeeks knowledge about political/societal issues post-gaming	t(58) = 2.12, $p < 0.001$***

3.3.3. 2 × 2 ANOVAs

Tables 3 and **4** below demonstrate a) the descriptives that correspond to participants' responses to the open innovation and global citizenship/sustainability-associated nexus explored during the post-gaming assessments by legal gender (i.e., male vs female) and municipality (Athens vs. other), and b) further describe the main and interaction effects as to gender and municipality for the corresponding open innovation and global citizenship/sustainability-connected post-gameplay continuum investigated. In addition, **Figures 3** and **4** below depict the nature of the interaction effects indicated based on legal gender and municipality for open innovation and diversity scores post-gameplay, respectively. **Tables 3** and **4** below present the results of the 2 × 2 ANOVA statistical analyses for open innovation and global citizenship/sustainability-linked assessments after controlling for legal gender and municipality origin after gaming. There was a significant interaction effect between legal gender and municipality origin on open innovation-related scores of attendees, F(1, 59) = 11,525, $p < 0.01$, partial $\eta^2 = 0.173$, reflecting that both male and female legal genders and Athens and other municipality origin employees were influenced differently in their open innovation-related orientation after-Resilience gaming. In specific, the open innovation-connected adaptation illustrated by attendees registered as legal male ($M = 4.34$) was significantly higher than those registered as legal female ($M = 4.33$) (x^2 (20) = 41,138, $p < 0.001$), while the scores reported by Athens municipality employees ($M = 4.37$) were significantly

higher than those exhibited by other municipality origin ($M = 4.31$) ($x^2 = (20) = 36,371$, $p < 0.01$). **Figure 3** below shows the nature of the interaction effect, depicting that Athens municipality significantly influences open innovation-associated orientation for legal male attendees. Moreover, there was a significant main effect of legal gender on interpersonal and problem-solving skills of global citizenship/sustainability continuum, $F(1, 59) = 4.781$, $p < 0.05$, partial $\eta^2 = 0.080$ (gender), which denotes that female legal gender participants scored significantly higher in their interpersonal and problem-solving skills than their male legal gender colleagues after-Resilience gameplay ($M = 4.00$ and $M = 3.66$, accordingly, estimated marginal means). However, this main effect of legal gender was not validated by either a significant main effect of municipality origin or an interaction effect of legal gender and municipality background on interpersonal and problem-solving skills of global citizenship/sustainability nexus after-Resilience gaming. Further, there was a significant main effect of municipality background on leadership skills of global citizenship/sustainability-related capacity, $F(1, 58) = 7.837$, $p < 0.01$, partial $\eta^2 = 0.127$, which indicates that employees originating from other than Athens municipality scored significantly higher in their leadership skills of global citizenship/sustainability-connected adaptation than their Athens colleagues after-Resilience gameplay ($M = 3.66$ and $M = 3.02$, accordingly, estimated marginal means). However, the aforementioned main effect of municipality background was not validated by either a significant main effect of legal gender or a significant interaction effect of legal gender and (or) municipality origin on leadership skills of global citizenship/sustainability orientation after-Resilience gameplay, denoting that male and female legal gender employees as well as Athens and other municipality participants were not affected differently in their leadership skills of global citizenship/sustainability-related ability after-Resilience gaming. Moreover, there was a significant interaction effect between legal gender and municipality origin on attendees' diversity scores of global citizenship/sustainability-orientation, $F(1, 59) = 16,411$, $p < 0.001$, partial $\eta^2 = 0.230$, reflecting that both male and female legal genders and Athens and other municipality origin participants were influenced differently in their diversity adaptation of global citizenship/sustainability orientation after-Resilience gameplay. In specific, the diversity-linked scores illustrated by attendees registered as legal gender males ($M = 3.42$) was significantly higher than those registered as legal gender females ($M = 3.33$) ($x^2 (9) = 15,621$, $p < 0.01$), while the scores indicated by Athens municipality employees ($M = 3.42$) were significantly higher than those exhibited by other municipality origin ($M = 3.27$) ($x^2 = (9) = 36,371$, $p < 0.10$). **Figure 4** below shows the nature of the interaction effect, depicting that legal male gender significantly affects diversity perceptions of global citizenship/sustainability of Athens background employees. In sum, therefore, the Resilience game seems to relate more male legal genders and Athens origin employees with open innovation and diversity reflecting global citizenship/sustainability-connected agency and capacity. **Figure 5** below outlines the conceptual model that reflects the indicated open innovation and diversity reflecting global citizenship/sustainability post-gaming outcomes, as next.

Table 3. Comparisons between employees' post-Resilience gaming responses related to open innovation separately after controlling for gender and municipality.

Open innovation	Gender (M, (MM))		Municipality (M, (MM))		2-way ANOVA between gender and municipality (a = 0.05)
Open innovation (OI) (47 items, a = 0.82)	Male	Female	Athens	Other	Main effect analysis: no significant difference between male and female (p almost equals to 0.2) and between Athens and other (p almost equals to 0.7). Interaction effect analysis: $F(1, 59) = 11,525$, $p < 0.01$, partial $\eta^2 = 0.173$. Male higher than female ($x^2 (20) = 41,138$, $p < 0.001$) and Athens municipality higher than other ($x^2 = (20) = 36,371$, $p < 0.01$) (**Figure 3**)
	4.34	4.33	4.37	4.31	
	(4.34)	(4.28)	(4.30)	(4.32)	

Notes: Male $N = 30$; female $N = 29$; Athens $N = 41$; other $N = 18$; total $N = 59$; α = Cronbach's Alpha, M = mean, MM = estimated marginal mean, a = the limit of the significant level.

Table 4. Comparisons between the participants' post-Resilience gaming reactions related to global citizenship attributes after controlling for gender and municipality.

Global citizenship attributes	Gender (M, (MM))		Municipality (M, (MM))		2-way ANOVA between gender and municipality (a = 0.05)
	Male	Female	Athens	Other	
Civic action (8 items, a = 0.80)	3.42 (3.43)	3.54 (3.56)	3.49 (3.48)	3.47 (3.51)	Main effect analysis: no significant difference between male and female (p almost equals to 0.4) and Athens and other (p almost equals to 0.8). Interaction effect analysis: no significant difference between gender and municipality (p almost equals to 0.9).
Interpersonal and problem-solving skills (12 items, a = 0.80)	3.68 (3.66)	3.98 (4.00)	3.90 (3.89)	3.66 (3.77)	$F_{(1, 59)}$ = 4.781, $p < 0.05$, partial η^2 = 0.080 (gender). Main effect analysis: no significant difference between Athens and other municipality (p almost equals to 0.5). Interaction effect analysis: no significant difference between gender and municipality (p almost equals to 0.3).
Political awareness (6 items, a = 0.82)	3.78 (3.76)	3.58 (3.64)	3.70 (3.73)	3.63 (3.66)	Main effect analysis: no significant difference between male and female (p almost equals to 0.5) and Athens and other (p almost equals to 0.7). Interaction effect analysis: no significant difference between gender and municipality (p almost equals to 0.2).
Leadership skills (5 items, a = 0.81)	3.42 (3.45)	3.00 (3.23)	3.00 (3.02)	3.68 (3.66)	Main effect analysis: no significant difference between male and female (p almost equals to 0.3). $F_{(1, 58)}$ = 7.837, $p < 0.01$, partial η^2 = 0.127 (municipality). Interaction effect analysis: no significant difference between gender and municipality (p almost equals to 0.6).
Social justice (8 items, a = 0.79)	3.83 (3.83)	3.59 (3.68)	3.66 (3.69)	3.81 (3.82)	Main effect analysis: no significant difference between male and female (p almost equals to 0.2) and Athens and other municipality (p almost equals to 0.3). Interaction effect analysis: no significant difference between gender and municipality (p almost equals to 0.2).
Diversity attitudes (5 items, a = 0.78)	3.42 (3.38)	3.33 (3.50)	3.42 (3.46)	3.27 (3.42)	Main effect analysis: no significant difference between male and female (p almost equals to 0.4) and Athens and other municipality (p almost equals to 0.8). Interaction effect analysis: no significant difference between gender and municipality (p almost equals to 0.2). Interaction effect analysis: $F_{(1, 59)}$ = 16,411, $p < 0.001$, partial η^2 = 0.230. Male higher than female (x^2 (9) = 15,621, $p < 0.01$) and Athens municipality higher than other (x^2 (9) = 36,371, $p < 0.10$) (**Figure 4**)
Seeks knowledge about political/societal issues (13 items, a = 0.80)	3.38 (3.39)	3.30 (3.21)	3.36 (3.36)	3.31 (3.23)	Main effect analysis: no significant difference between male and female (p almost equals to 0.2) and Athens and other municipality (p almost equals to 0.3). Interaction effect analysis: no significant difference between gender and municipality (p almost equals to 0.2).

Notes: Male N = 30; female N = 29; Athens N = 41; other N = 18; total N = 58; $α$ = Cronbach's Alpha, M = mean, MM = estimated marginal mean, a = the limit of the significant level.
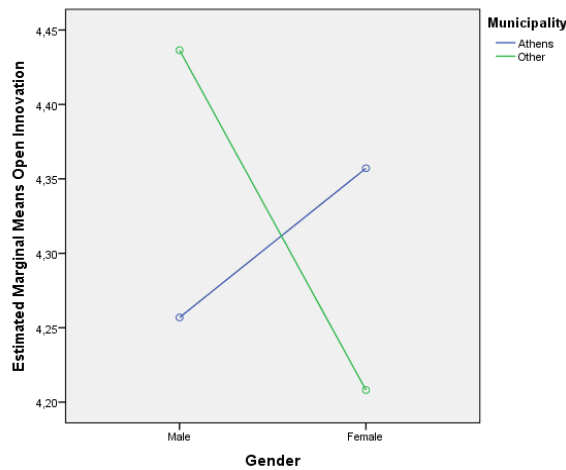
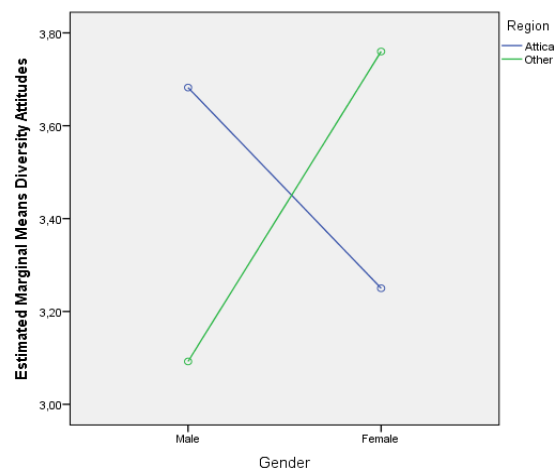**Figure 3.** Interaction effect for open innovation after-Resilience gameplay by gender and municipality.

Figure 4. Interaction effect for diversity attitudes after-Resilience gameplay by gender and municipality.
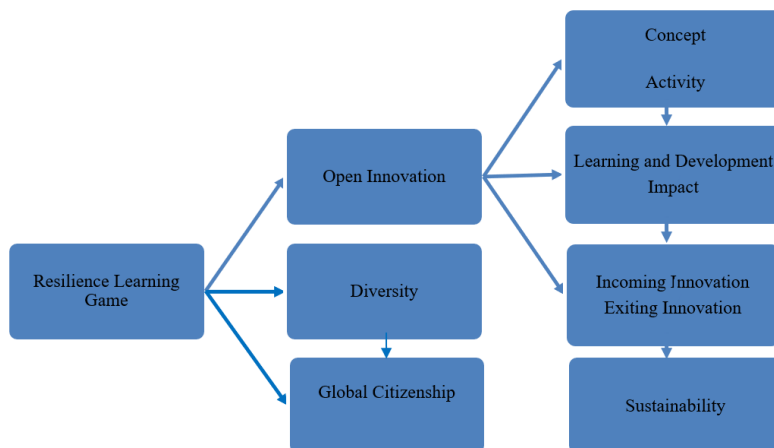

Figure 5. Outline of conceptual model indicating Resilience open innovation and global citizenship reflecting sustainability post-gaming iterative nexus.

4. Discussion

The present study aims to be inspired by embedding and exploring two emergent challenges: the learning game instruction (immersive teaching and learning) with/and both the open innovation-and-global citizenship reflecting sustainability attributes in IT and Telecom industry in Greece. The results obtained in the current research seem to associate current employees with overall positive a) open innovation-related (i.e., co-

development, open data and sharing, business intelligence, systems design thinking, product and service development, risk sharing, IP management, project management, technology innovation, R&D, communities of practice, public sector, higher education, industry stakeholders, government) and b) global citizenship-associated knowledge, attitudes and skills (i.e., engagement in community and environment, empathy, problem-solving and logical thinking, knowledge of local, community, worldwide and political events, making difference in the world and leading others, global mindset in solving social challenges, seeking public policy change to support equal and inclusive society, looking for cultural diversity in interaction, and being updated on nation-wide politics, regional, city, community and wider political events) after-Resilience gaming compared to workshop learning and development. In addition, the reported findings tend to associate open innovation-related continuum with a) logical challenge-solving, working cooperatively with others, constructive communication, placing oneself in others' position (i.e., interpersonal and problem-solving skills), b) liaising with cultural diverse groups of people (i.e., diversity), and c) seeking updates on current local, community, city, region, nation-wide and global political decisions, processes, and news that reflect national and global social, environmental and human development challenges (i.e., seeking knowledge about political/societal issues) post-Resilience gameplay. Further, the indicated results seem to link legal male employee genders and those originated from Athens municipality with both higher open innovation-related and diversity attributes (mapping into global citizenship) after-Resilience gaming. Taken all together, the aforementioned empirical evidence seems to a) lend support and extends prior favourable open innovation-and-global citizenship-gaming associated attributes explored in pre-college and higher education in Thailand and UK[6,7] to corresponding research in Greek IT and Telecom industry, b) expands previous positive global citizenship agency and capacity evidence of community college learners in USA[17] to similar current Resilience-gameplay attributes in Greek IT and Telecom workforce (i.e., diversity, interpersonal and problem-solving skills and seeking knowledge about political/societal issues), and c) extends earlier findings that reveal individual differences (e.g., region/municipality origin)[18]: for global citizenship/service learning-associated continuum explored in higher education in Taiwan to current open innovation-and-global citizenship-gaming Greek IT and Telecom work context. Revealing the innovative connection of open innovation (inflow and outflow innovation) with global citizenship-associated attributes (diversity, interpersonal and problem-solving, and seeking knowledge about political/societal challenges) reflecting sustainability in learning game environment and that of Resilience tool, in specific. Further revealing the role of legal gender in both open innovation- and- global citizenship-related Resilience-gameplay attributes assessed in Greek IT and Telecom industry. In particular, contradicting previous evidence that reports higher levels of global civic agency and capacity for USA college legal female genders[19] and expanding those to current Resilience-gaming industry domain. In addition, the main effects initially indicated for legal gender employees regarding interpersonal and problem-solving skills and municipality origin participants concerning leadership skills post-Resilience-gaming that did not seem to be further validated by an expected significant interaction between legal gender and municipality origin, might be tentatively assigned to other factors potentially taken into consideration and already demonstrated in favour of global civic agency and capacity continuum mirroring interpersonal and problem-solving and leadership skills (in specific)[14,18] explored across USA college environment and transferred to current Resilience-learning gameplay (in particular). The revelation of favourable Resilience-gaming instruction in relation to conventional learning and development delivery in terms of open innovation-and-global citizenship/sustainability development-related knowledge, attitudes and skills expanded to IT and Telecom Greek industry settings supported by individual differences human development elements (i.e., legal gender and municipality origin), tends to echo promising evidence for emerging open innovation and global sustainability and resilience research that reflects inclusive and sustainable "engaged" scholarship. Associating immersive learning game technology learning and development with inflow and outflow aspects of innovative sustainability progression in cross-cultural computer science and engineering domain[4,5]. Extending learning game vs traditional instruction research across diverse higher education and industry intersectoral

environments involving learners and educators, by targeting to disentangle further specific aspects of open innovation and global civic-related continuum in particular, might well serve supporting emerging open innovation and global citizenship/sustainability mindset further. Taking into account the role that legal gender, cultural origin and (or) self-regulated learning might endorse for in-game performance[20,21]. Thereby, facilitating additional research on whether and how technology innovation can foster inclusive and sustainable citizenship in favour of global human development and resilience.

5. Conclusion

The Greek IT and Telecom industry employees indicated higher open innovation and global citizenship/sustainability-associated account after-Resilience gaming, compared to traditional workshop. In addition, post-Resilience gameplay, open innovation-associated continuum seemed to be connected to: logical thinking, challenge/problem-solving, collaboration, effective communication, empathy (i.e., interpersonal and problem-solving skills), diverse group interaction (i.e., diversity attitudes), and being updated on city, community, regional, national and universal political decision-making, events, and news that tend to impact on nation-wide and worldwide acute social, economic, and environmental resilience issues (i.e., looking for updates on political/societal topics). Finally, the acquired outcomes seem to highlight the role of individual differences account indicated by legal male gender and Athens origin effect on greater open innovation-and diversity/global citizenship-related attributes post-Resilience gameplay. A longer-term exploration of open innovation and global citizenship/sustainability attributes during conventional and learning game delivery disentangling further a) particular aspects of open innovation-associated continuum across intersectoral industry and higher education infrastructure, b) involving executives and supervisors, and c) investigating learning game mechanics and user interface impact on facets of multiple intelligence[22] might advance learning game open innovation in science sustainable continuum effectively.

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Conflict of interest

The author declares no conflict of interest.

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