Development and Evaluation of Two 3D-Simulated Practice Learning Environments

Stephen Farrier, Independent Researcher, UK*

Thomas M. Connolly, DS Partnership, UK

https://orcid.org/0000-0002-4276-7301

Nikolina Tsvetkova, University of Sofia, Bulgaria

https://orcid.org/0000-0002-1512-7712

Mario Soflano, Glasgow Caledonian University, UK

https://orcid.org/0000-0003-0758-1509

Petros Papadopoulos, Strathclyde University, UK

https://orcid.org/0000-0002-8110-7576

ABSTRACT

This paper discusses the evaluation of two 3D simulated practice learning environments, *Tiny Oaks* and *Play2Do*, focused on supporting people working with children, families, and vulnerable people in special educational settings. Pre-test/post-test evaluation methodology was employed consisting of a questionnaire with 16 questions covering knowledge and understanding, professional practice, and transferable skills. *Tiny Oaks* had 530 participants pre-test and 423 post-test from six European countries, and results show a significant increase in learning across all questions. *Play2Do* had 318 participants pre-test and 301 participants post-test from the UK and Bulgaria, and again results show a significant increase in learning across all questions. The system usability scale (SUS) questionnaire was also used to measure the usability of the two environments, and usability was found to be excellent. Findings suggest that 3D simulated practice environments can provide a valuable learning experience and can provide practice learning scenarios that may be difficult to encounter in real-life.

KEYWORDS

Evaluation, Games, Post-Secondary Education, Practice Learning, Simulations

INTRODUCTION

This paper discusses the evaluation of two 3D simulated practice learning environments, *Tiny Oaks* and *Play2Do*, focused on supporting people working in health, social care with children, families and vulnerable people in special educational settings. The importance of health, social care and special education services is increasing as society changes dramatically and practice/professional learning evolves to meet these changing dynamics. This growing demand for services is creating unprecedented pressures on health, social care and special education systems. Despite differences in

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political approaches and institutional frameworks, health, social care and special education services face similar challenges in adjusting to demographic change, rising expectations and consumerism, changing employment and family patterns, funding and evolving technological and distributed learning opportunities of service users for trainees, practitioners and professionals as learners.

We have developed two immersive 3D simulated practice learning environments that provide safer and more accessible environments in which students and professional social workers who deal with vulnerable people can learn by interacting with NPCs (non-player characters) in a simulation of a real-world service. Trainees engage with simulations and are required to navigate their way through choices to arrive at the best resolution. Each simulation can be replayed and evaluated by the trainer/mentor and the trainee can use the same simulation as many times as required. We see this as offering a measurable, controlled environment where learners can gain a command of the basics of the job role, they are training for with minimal resource requirements and zero risk to the public, thus providing a sound basis from which to progress to real work practice placement. Previous publications have discussed a small expert evaluation of the childhood practice environment (Hainey *et al*. 2014a) and the results of a larger preliminary evaluation of this environment with 20 Social Science students to gain empirical evidence in the field and to collect data for potential areas of improvement to the game and evaluation instruments (Hainey *et a*l., 2014b). The current paper focuses on an evaluation of the results of students and professional staff using these two environments for learning.

The need to devise new ways of conducting interactive and immersive practice learning simulations was made more evident during the COVID-19 pandemic, especially during the periods of enforced working and studying from home. The pandemic and the social distancing measures made it difficult and, in some cases, impossible to conduct face-to-face classes and practice learning in real settings. Healthcare and social work practitioners had to quickly adapt their teaching to the online environment in ways beneficial to the learners. Pan and Rajwani (2021) point out the central role of simulated practice is to "*refine protocols, facilitate practice changes, uncover safety gaps, and train redeployed healthcare workers in unfamiliar roles*". Ying and Liaw (2022) argue the need to use different modalities in nursing education such as video and teleconferencing as well as computer simulations. Díaz-Guio et al. (2021) evaluate the effectiveness of online-synchronised clinical simulation in health science education focusing more precisely on briefing, simulated cases and debriefing. In a specially designed simulated practice environment, Musa et al. (2021) suggest that it is interactivity which "*promotes higher order learning, increases teamwork and enhances the perception of authenticity*".

Therefore, investment in practice-based learning is key to ensuring that practitioners and professionals continue to meet changing service needs and engage in activities that support the growth and transformation of a practice and/or profession. The drive to grow the workforce so that the supply of competent practitioners and professionals keeps pace with demands of health, social and special education services create a tension around practice-based learning within a real-world context. Therefore, integrating practice learning into the context of 3D simulated practice learning environments may lead to greater learning motivation and thus to more effective learning when compared with traditional teaching methods.

Education and training play a pivotal role in developing those who work within these health, social care and special educational environments such as the ones expressed within the *Tiny Oaks* and *Play2Do* projects discussed in this paper and impact more generally across the social care and special education services sector. In many parts of Europe, the sector has a strong emphasis on learning and assessing skills for job roles in real practice environments ("practice learning"). In some qualifications, practice learning can be almost 40% of the total learning time. There are also on-going demands for practice learning with new qualified professionals and professionals as part of CPD (Continuous Professional Development). There are clear logistical challenges in arranging practice opportunities where trainees are able to learn the core skills of the job and receive high quality support, supervision and assessment of their practice from suitably qualified mentors/practice assessors. Furthermore, finding sufficient

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numbers of such placements has been a challenge for the last 30 years. However, there are also other challenges; e.g., risks associated with work-based learning and the safety and well-being.

The structure of this paper is as follows. In the next section, we examine the literature related to social work education and serious games. In subsequent section, we provide an overview of two 3D simulated practice environments called *Tiny Oaks* and *Play2Do* followed by a presentation of the experimental design and the results of piloting that has been provided for students and professional staff in the use of the simulated practice environments. The final section provides some conclusions and future directions.

BACKGROUND

Practice Learning

Education for health, social work and education aims to prepare students in the professions' fundamental ways of thinking, performing and acting with integrity (Shulman, 2005). Competence frameworks with a focus on outcomes have been adopted in some countries for professions such as medicine, nursing, psychology, pharmacy, quality management, teacher education, and social work. Competence refers to complex practice behaviours reflecting knowledge, skills, values and attitudes that students should be able to demonstrate on completion of their degree. While social work programmes adopt traditional assessment methods to assess learning using, for example, written examinations, essays, student presentations, or portfolios (Bottomley et al., 2018), the ability of an individual to perform the core functions of the profession in practice situations is of fundamental importance (Finch & Schaub, 2018).

In the UK and many other countries, all students who are training to be registered social workers are required to complete practice learning/practice placements in accordance with requirements and guidance from various bodies, for example, in the UK, The Health and Care Professions Council (HCPC), The Quality Assurance Agency (QAA), The College of Social Work (TCSW), Scottish Social Services Council (SSSC). Social work practice is complex and practice learning is an opportunity for students to work directly with service users and carers and to apply and develop their knowledge, skills, values and ethics and build on their learning within the taught elements of their programme. In education, it is the (School Teachers Qualifications, England regulations 2003 and the General Teaching Council Scotland. Educational practitioners engage in practice learning to stimulate their thinking and professional knowledge and to ensure that their practice is critically informed and current. When a wide range of high quality, sustained professional learning experiences are undertaken, educators are more likely to inspire learners, providing creative and innovative teaching and learning experiences, enabling learners. Practice learning provides creative opportunities for educators to enhance their professional and propositional knowledge and practises.

With practice-based learning, theory and work experience are combined with a strategic, reflective process throughout the duration of your learning. A learner does not just learn the theory first and then jump into the classroom and apply it afterward. Instead, the learner implements the theory in complex situations in multiple learning and practice environments, individually and collaboratively, as they learn it, assess its effectiveness. Therefore, it can be argued that the goal is to become a self-sufficient professional who has the capacity to develop, measure, redesign, continuously evolve and grow their own professional practice.

Practice Learning and a Curriculum for Innovation

In practice, professional learning communities are being increasingly developed to stimulate the sharing of knowledge, information and expertise among teachers and educators, with the goal to improve student learning and practice. According to Korthagen (2010) by engaging in professional and practice learning activities teachers can make knowledge and information explicit, discover the proper scripts for future actions aimed at adaptation to changes such as ongoing reorganizations of work processes and accountability reforms, and to formulate and monitor goals for further development of for instance instructional methods and technological innovations. With the application of practice

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learning it is worth considering whether it can be formulated as situated and rehearsed practice learning and its impact in the form of educational pedagogy. Situated learning theory states that every idea and human action is a generalization, adapted to the ongoing environment; it is founded on the belief that what people learn, see, and do is situated in their role as a member of a community (Lave & Wenger, 1991).

Eraut (2000) believes non-formal learning and tacit knowledge in professional work is learning about other people and learning to use scientific and other forms of academic knowledge in practice contexts. Professional, managerial and technical performance are normally complex and typically involve the simultaneous use of several different types of knowledge and skills, which have to be learned more holistically. Eraut further postulates that this affects how, and how much, people think while they are in action, and puts 'ready-to-use' knowledge at a premium. In context, practice learning in simulated and rehearsed workplace environments focus on what is being learned, how is it being learned and what factors affect the level and directions of learning effort. These types of new and innovative knowledge acquisition and new knowledge architectures, such as immersive learning, practice learning, situated and rehearsed learning as well as gaming architectures are influencing new pedagogical interventions for use in these complex learning and practice situations.

Practice Learning in Higher Education

Since the 1980s there has been significant growth in the engagement of higher education with workforce development, from which evidence of practice emerged, particularly in clinical environments where critical practice, critical incidence and evidence-based practice were resident. Lester and Costly (2010) comment that examination of practice learning indicates a growing sophistication in the way that work-based learning is being theorised and facilitated in higher education, with its gradual emergence as a distinct field of practice and study supported by relevant pedagogies and concepts of curriculum. Consequently, over the last 20 years, tensions continue to exist between the demands and opportunities provided by the workplace and the need to develop realistic and capable practice that support and sustain personal through continuous professional development and yet still maintain academic validity. However, universities are beginning to engage with these issues at a deeper level than that suggested by simple notions of employer engagement and skills development, indicating that well-designed innovative and evidence-based practice learning environments and immersive learning innovation learning programmes and environments are both effective and robust.

Wrenn and Wrenn (2009) consider that educators in professional or practice-related fields want their students not only to learn theory and understand why theories are important but also to learn how to apply the theoretical frameworks in practice. The difficulty in making the transition from theory to practice arises, at least in part, from a failure of the teacher to integrate both theory and practice into the same course in the curriculum in ways that are relevant and meaningful to the student. It can be suggested that such integration helps learners to more closely associate the practical value of learning theoretical concepts. In this context in this new era of digital transformation and digital literacy, serious games are becoming increasingly essential within the development of innovate immersive practice learning environments.

Practice learning, when defined in both higher education curriculum and undergraduate educational programmes are designed to identify and manage personal and professional learning needs. The outcome of such curricula observed would develop change related to current practice and the intention for possible initiation of changes in practice when relating to relevant practice environments and stakeholders. When designing and constructing educational programmes and curricula it is important to recognise that the focus is to identify and demonstrate evidence-based knowledge of practice, context and mechanisms required to instigate change/develop to the learners' continuous professional practice, through the application critical analysis of theory and research to practice development.

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Previous Approaches to Practice Learning

One approach to experiencing practice learning is through simulation-based education where students engage in an imitation of an activity to learn. Simulation is a form of experiential learning designed "*to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner*" (Gaba, 2004, p. i2). This approach is frequently used to develop empathy and empathetic behaviours in medical and health-related students (Bearman et al, 2015). Simulation techniques in health and social work vary and include role play (Craig et al., 2017); scenarios played out by drama students (Duffy et al, 2021); and use of trained actors (Lee et al., 2020). Research validating the effectiveness of simulation-based learning has mainly been in the healthcare domains including medicine (Abdool et al., 2017) and nursing (Lavoie et al., 2018). The research indicates that simulation improves learners' skills and that learning through simulations is also associated with improved patient outcomes (Egenberg et al., 2017). From a theoretical perspective, simulation-based education builds on adult learning theory (Knowles, 1984) and experiential learning theories (Kolb, 1984) contributing to learning through experience and reflection (Kourgiantakis et al., 2020).

Another approach that has been used to supplement traditional assessment methods is the objective structured clinical examination (OSCE), which was developed in the 1970s for medical education (Harden et al.,1975). It originally consisted of 16 stations, each 5 minutes in duration, with some stations having real patients or actors to test students' skills in history taking or examinations and other stations requiring students to answer written questions relating to previous stations or questions linked to some clinical artefact such as an X-Ray. Students moved between stations at fixed intervals. Examiners stayed at their allocated station throughout the session and so students were assessed by 16 different people, but all were assessed using a near-identical process. In current OSCEs, students interact with standardised patients (SPs) or clients (SCs) for a set period of time and perform a series of tasks. SPs and SCs are actors specially trained to enact a situation typical of that profession. Using standardised scales to measure competence, an instructor observes and evaluates student performance. This approach is now used to assess other health professionals such as nurses (Johnston et al., 2017), dental hygiene students (Kerkstra et al., 2018), radiographers (Taylor & Quick, 2020), optometrists (Hrynchak et al., 2021), pharmacists (Kristina & Wijoyo, 2019), physiotherapists (Ferreira et al, 2020) and also social workers (Bogo et al., 2012).

Challenges with Practice Learning

Practice learning connects to a broader strategy of continuous practice and professional development but presents challenges inherent with its design (e.g. is it directly observable, is it actionable). Identifying a problem of practice is the first step and element of instructional rounds. Practice learning demands attention to detail and when considered as transformative through digital design. Therefore, practice learning environments need to be designed to meet the experiences of different learners, and need to be considered in resource terms, both financial and physical. Although digital applications of practice learning indicate flexibility of approach it also demands digital proficiency and innovate pedagogical design as well as ongoing support and learning facilitation. Resistance is also a key challenge in its application and changing this culture can be difficult.

It can be suggested that few are aware of how great the cultural change is likely to be when digital practice learning becomes more widespread and the ways in which we facilitate practice and situated learning will change greatly. Therefore, we must seek to manage these pedagogical changes in design and delivery patterns developed and implemented by educators. A primary indicator is the encouragement of a mindset that generates content in a digital from. Therefore, there is a need to explore ways of using digital learning technologies to enhance the learning capacity of learners through innovative immersive learning scenarios and learning environments.

There have been various concerns raised about practice learning on social work programmes, particularly quantity and quality of placements (Finch & Taylor, 2013). Difficulties in finding sufficient, good-quality opportunities for practice learning are not restricted to the social work and

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education profession and practices. Shortages of supply have resulted in substantial research and development of alternatives such as the use of a collaborative model (one educator works with two students) (Fisher & Savin-Baden, 2002); and role-emerging placements (placements that occur in settings that have previously not experienced or identified a discipline role) in occupational therapy (Thew et al., 2008). The potential of technology to provide virtual placements has also been explored (Jefferies et al., 2021).

Serious Games

Serious games have increased in popularity as a form of supplementary learning over the past decade and have been used in a number of different disciplines including: health (Gorbanev et al., 2018; Chon et al., 2019), computing (Soflano et al., 2015; Hart et al., 2020), languages (He, 2022), mathematics (Barbieri et al., 2021), engineering (Urgo et al., 2022), science (Kara, 2021) and cultural heritage (Ye et al., 2021). Games and simulations fit well into the constructivist paradigm and "*generally advocate the active acquisition of knowledge and skills, collaboration and the use of authentic and realistic case material*" (Brown et al., 1989). As well as the usual cited advantages of serious games such as increased engagement and motivation, Tang et al. (2009) provide a compiled list of pedagogic advantages of serious games. These include (i) encouragement of learners to take a problem-solving approach in learning; (ii) instant feedback to correct misconceptions and promote formation of concepts thus increasing learners' understanding of a subject area; (iii) increased retention of information through learning by game-playing; (iv) aid in acquisition and development of cognitive abilities that are not formally taught in education; (v) promotes deep learning by arousing learners' curiosity on certain subjects.

One advantage of serious games that is particularly relevant for simulated practice is that it can provide risk free environments (Kirriemuir & MacFarlane, 2004). Fontana and Beckerman (2004) report that "*students can instruct themselves, repeating simulations as often as they wish without the embarrassment of addressing somewhat sensitive issues.*" An advantage of simulated practice games is that errors are less threatening compared to other classroom methods of instruction.

PROPOSED APPROACH

By developing the 3D simulated practice environments, we aim to computerise the standardised client of OSCE by having a number of vulnerable people and a number of scenarios that the learner can interact with and make decisions that simulate what might be encountered during practice learning and during their future professional careers. As examples of vulnerable people, we have focused on using one simulated practice environment for childhood practice education and have set the game with young children in a nursery and the second simulated practice environment for teachers and professionals who work with young people with intellectual and/or developmental disabilities. Note, though, we are not promoting 3D simulated practice learning as an alternative to live placements, but as a complement to them, and possibly as a substitute for some of the functions that are currently expected of the live placement.

THE SIMULATED PRACTICE ENVIRONMENTS

The *Tiny Oaks* 3D Simulated Practice Environment

The *Tiny Oaks* simulated practice environment has been designed by an advisory group consisting of subject matter experts in childhood practice. A number of general activities was formulated for the 3D practice learning environment, which focuses on a morning session at a nursery from the arrival of children with their parents/carers, through the children participating in various activities until they are collected by their parent/carer. Activities modelled include: painting area – table top painting, painting easel; messy play area – sand tray, water tray; activity table – gluing, modelling, clay and

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play dough; construction area; home corner; role play area; reading corner; music area; imaginative play – puppet theatre; investigation area; activity table – board games, jigsaw puzzles, small world play; snack preparation area - plus chairs and tables for children to sit at to eat snack; and a computer area. The environment has been populated with 16 children, 1 practitioner (maintaining an 8:1 ratio of children to practitioners) and one student practitioner. The two NPC practitioners are there to help the player look after the children during the game.

The gameplay involves the player taking on the role of a childhood practitioner and navigating the 3D nursery environment to deal with one or more scenarios running concurrently to give a realistic representation of what childhood practitioners have to cope with in the nursery environment.

During the session, a number of scenarios may arise that the player has to deal with in an appropriate way. The introductory scenario (*Risk Assessment mini-game*) has a twofold purpose - to provide the learner with an opportunity to get used to the look and feel of the game and to apply their prior knowledge about the requirements for a risk-free environment in a nursery setting. The other eight scenarios depict typical situations airing in a nursery, which require a child care practitioner to take different kinds of actions connected with interactions of the type child-child and child-child care practitioner (disagreement and developmentally normal low-level aggression among children; accidents involving children's physical and psychological well-being; responsiveness to a child's communication preferences and needs; encouraging a child's self-reliance, self-esteem and resilience; identifying schematic play and engaging in a child's learning), child-parent and child care practitioner-parent (communicating issues arisen during the day at the nursery; offering reassurance to both child and parent when a child is left to spend the day at a nursery). Figure 1 shows an example of the implemented simulated practice game.

Figure 1. The implemented Tiny Oaks simulated practice game

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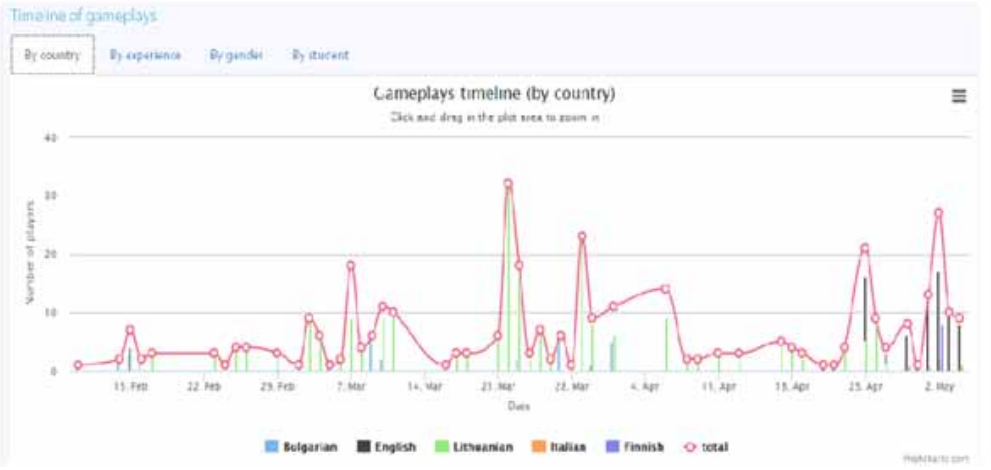
In every scenario, a player interacts with the game characters by choosing one of three given options. After a choice is made, one of three colours flashes in the left top corner of the screen: green indicates that the player has made the right choice; orange indicates that the player's choice does not really have an effect on how right/wrong the player is; red shows that the chosen option leads along the wrong path to follow. If a player chooses the 'Badges' icon, feedback on the respective scenario is obtained. Alternatively, the player can choose to receive feedback by email when prompted during the game.

As in a real-life setting, players can take notes of different things they observe while playing. These are recorded using the Observation notes available at the nursery desk. Alternatively, the notes are accessible through the Journal that is always accessible during the game. The aim is again twofold – to provide a taste of a real-life nursery setting and an opportunity to critically reflect on the arising situations.

The game has been implemented in Unity 5 and the animated characters have been produced in Maya. The game has been built using the cloud-based EngAGe engine for assessment and feedback (Chaudy et al., 2014a and 2014b). EngAGe provides an API (application programming interface) and a set of web services that supports games developers in adding assessment and feedback into their games. As well as supporting developers, EngAGe provides data visualisation and learning analytics facilities that allows educators to see how their students are performing (see Figure 2). The game is also multi-lingual (currently English, Finnish, Italian, Lithuanian and Bulgarian languages are supported).

Figure 2. Example output from the EngAGe learning analytics



The *Play2Do* 3D Simulated Practice Environment

The *Play2Do* simulated practice environment has also been designed by an advisory group consisting of subject matter experts in dealing with young people with intellectual and/or developmental disabilities. Six scenarios were developed to represent possible real-life scenarios in a school setting based around the interactions between mainstream students, special educational needs (SEN) students, teachers and parents. The scenarios provide insights into certain conditions requiring special education such as dyslexia, Autistic Spectrum Disorders, *Attention Deficit Hyperactivity Disorder, hearing difficulties, epilepsy and behavioural problems. The scenarios make it possible for a future/in-service professional to practice* working with both mainstream and SEN pupils, to suspend judgement and keep an open mind towards disabilities and developmental difficulties, to identify behaviours that may escalate into a challenging situation and to deal with such, to create a positive and calm learning environment, to promote effective communication

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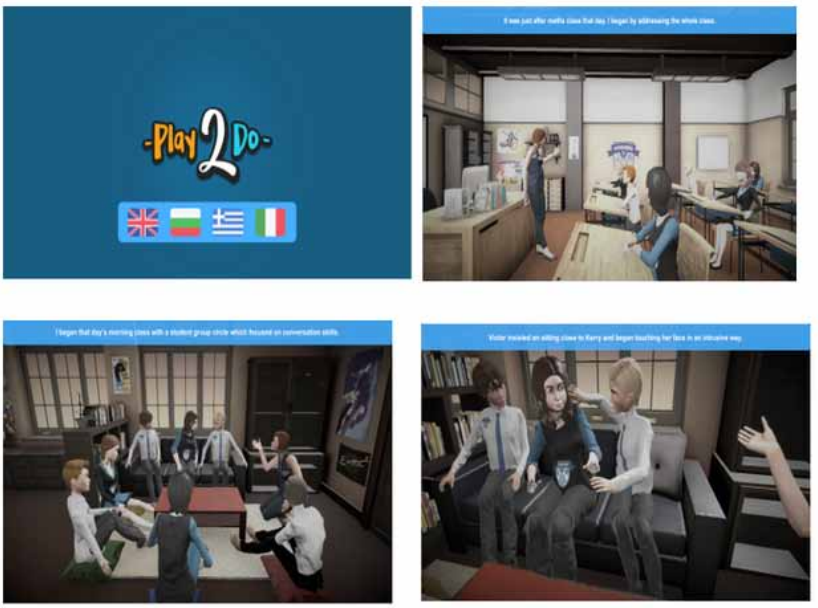
in the classroom and deal with group dynamics, setting the rules of and boundaries within the classroom, to practise communicating with parents what has happened in the classroom.

In each scenario, the player interacts with students in a classroom setting. The scenarios are rendered as stories narrated by a teacher and at critical points the player is prompted to choose between different actions. Actions aggravating the situations lead to a scenario end while appropriate ones lead to the scenario evolving further. Feedback is provided at the end of each scenario. Figure 3 provides some screenshots from the game.

The game has been implemented in Unity 5 and the animated characters have been produced in Maya. The game is multilingual – so far English, Italian, Greek and Bulgarian are implemented. Both games are built in a training course accompanying the simulated practice learning experience which provides further opportunities to reflect on and discuss the issues tackled in the games in a broader context.

Figure 3. The Play2Do simulated practice game



EXPERIMENTAL DESIGN

The purpose of this paper is to discuss the results of evaluating both simulated practice environments with students and professional social workers. The evaluation occurred for the *Tiny Oaks* simulated practice environment in 2016/17 and for *Play2Do* in 2018. In both cases, participants were asked to complete a pre-test questionnaire before playing the game and a post-test questionnaire on completion of playing the game. Nobody participated in both experiments.

Materials

A pre-pilot questionnaire was constructed asking participants the following: gender, country, profession (e.g., student, social worker/teacher/other), number of years employed (if participant is in professional practice) or the number of years the participant has been a student, number of hours spent playing computer games each day (none, less than 1 hour per week, 1-7 hours per week, greater than 7 hours per week). This was followed by a set of questions based on (1) their knowledge and

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understanding; (2) the application of practical and professional skills on their experience; and (3) transferable skills. These questions were based on a 5-point Likert scale: "Strongly agree" (assigned value 1 in the analysis), "Agree" (assigned value 2), "Neither agree nor disagree" (assigned value 3), "Disagree" (assigned value 4) and "Strongly disagree" (assigned value 5). The post-pilot followed a similar structure and asked participants similar questions but after they had played the game. There was also a set of questions to determine the usability of the game.

Methodology

The methodology selected for the evaluation of the 3D simulated practice games was a pre-test/post-test experimental design which consisted of the following steps:

- completion of the pre-test questionnaire;
- playing the in-game tutorial;
- playing through the scenarios in the simulated practice environment;
- completion of the post-test questionnaire.

Data Analysis

The statistical data analysis techniques selected for this study were non-parametric statistical tests given that the data did not adhere to the three pieces of criteria required for the use of parametric tests: normal distribution, homogeneity of variance and ratio or interval data (Shapiro-Wilk tests showed that the data significantly deviated from a normal distribution). The primary statistical analysis technique used to compare the pre- and the post-test groups were Wilcoxon matched pairs signed rank tests (the non-parametric equivalent of the dependent t-test). Analysis was performed using SPSS version 28.0.1.

RESULTS

Results for *Tiny Oaks* Simulated Practice Environment

530 participants completed the **pre-test** questionnaire with 478 of the participants (90.2%) being female and 52 participants (9.8%) being male. The participants were mostly from Europe with 193 (36.4%) participants from the UK, 147 (27.8%) from Bulgaria, 102 (19.2%) from Lithuania, 54 (10.2%) from Italy, 17 (3.2%) from Finland, and 17 (3.2%) from Germany. In terms of occupation, 268 (50.5%) of the participants were in a relevant professional employment, 249 (47%) were students and 13 (2.5%) had a different employment status. In terms of experience of computer games, 229 (43.2%) participants did not play computer games, 198 (37.4%) occasionally play (less than one hour per week), 83 (15.6%) play between one and seven hours per week and 20 (3.7%) are frequent game players (more than seven hours per week). The students had been in study for an average of 2.26 years (SD = 1.35) with a range of 0 to 12 years and the professional staff had an average of 16.51 years' experience (SD =11.48) with a range of 0 to 44 years.

Items measured for knowledge and understanding indicated a high level of internal consistency (Cronbach's $\alpha = 0.958$) and professional and transferable skills (Cronbach's $\alpha = 0.888$). In addition, the removal of each item resulted in a lower Cronbach's α indicating the importance of each item. Table 1 shows the mean, standard deviation and ranking for the participants' responses to questions relating to (1) their knowledge and understanding; (2) the application of practical and professional skills on their experience; and (3) transferable skills.

423 participants completed all the questions in the **post-test** questionnaire with 378 of the participants (89.4%) female and 45 participants (10.6%) male. The participants were mostly from Europe with 107 (25.3%) participants from the UK, 131 (31.0%) from Bulgaria, 103 (24.3%) from Lithuania, 54 (12.8%) from Italy, 11 (2.6%) from Finland, 14 (3.3%) from Germany and 3 (0.7%) from elsewhere. In terms of occupation, 220 (52.0%) of participants were in a relevant professional employment, 192 (45.4%) were students and 11 (2.6%) had a different employment status. In terms

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Table 1. Participants' Answers to Knowledge, Understanding and Skills Questions

	Tiny Oaks			*Play2Do*		
Area One: Knowledge and Understanding – I think I know how to	**Rank**	**Mean**	**SD**	**Rank**	**Mean**	**SD**
actively promote health, safety and security at my (future) workplace while working with children	1st	1.90	0.91	3rd	1.75	0.75
apply child-centred, rights-based approaches to working with children	2nd	1.91	0.94	=4th	1.77	0.74
actively promote effective communication while working with children and their parents	3rd	1.92	0.87	1st	1.68	0.69
actively promote children's well-being and resilience in my (future) work context	4th	1.96	0.81	=7th	1.82	0.71
constantly develop my practice with children and their families through reflection and learning	5th	1.97	0.89	=7th	1.82	0.71
actively promote the development of children and young people in my (future) work context	6th	2.01	0.89	9th	1.83	0.74
make personalised provision for children taking account of their age and specific needs	7th	2.02	0.93	6th	1.81	0.74
effectively organise and plan environments for children and their families in my (future) work context	8th	2.15	1.07	2nd	1.73	0.59
the key characteristics of a quality curriculum for young children	9th	2.25	1.12	=4th	1.77	0.58
Area Two: Application of practical and professional skills through reflective practice - I think I am able to						
constantly reflect on and stay engaged in the systematic observation of my own practice with children	1st	1.92	0.82	2nd	1.81	0.65
successfully connect my actions to day to day practice with children	2nd	1.95	0.88	1st	1.80	0.82
evaluate and further develop programmes to maximise the opportunities for effective engagement by children	3rd	2.43	1.03	3rd	2.03	0.65
question and analyse concepts and understandings of national, regional, local or EU policies relating to children and young people	4th	2.58	1.04	4th	2.08	0.57
Area Three: Transferable skills - I think I am able to						
objectively assess my own effectiveness in working with children and their families	1st	2.06	0.81	1st	1.91	0.59
demonstrate my ideas in writing	2nd	2.10	0.87	2nd	2.00	0.59
effectively communicate my ideas in collaboration with other "players" in my local context	3rd	2.37	1.03	3rd	2.10	0.61

of experience of computer games, 179 (42.3%) participants didn't play computer games, 167 (39.5%) occasionally play (less than one hour per week), 66 (14.4%) play between one and seven hours per week and 16 (3.8%) are frequent game players (more than seven hours per week). The students had been in study for an average of 4.40 years (SD = 6.32) with a range of 0 to 12 years and the professional staff had an average of 13.17 years' experience (SD =12.05) with a range of 0 to 44 years. Table 2 shows the mean, standard deviation and ranking for the participants' responses to questions relating to (1) their knowledge and understanding; (2) the application of practical and professional skills on their experience; and (3) transferable skills.

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Table 2. Participants' Answers to Knowledge, Understanding and Skills Questions

	Tiny Oaks			*Play2Do*		
Area One: Knowledge and Understanding – I think I know how to	**Rank**	**Mean**	**SD**	**Rank**	**Mean**	**SD**
actively promote health, safety and security at my (future) workplace while working with children	1st	1.48	0.58	6th	1.51	0.59
constantly develop my practice with children and their families through reflection and learning	2nd	1.50	0.64	5th	1.50	0.60
apply child-centred, rights-based approaches to working with children	=3rd	1.51	0.64	1st	1.42	0.56
actively promote effective communication while working with children and their parents	=3rd	1.51	0.60	3rd	1.48	0.56
make personalised provision for children taking account of their age and specific needs	=3rd	1.51	0.64	2nd	1.45	0.58
actively promote the development of children and young people in my (future) work context	6th	1.52	0.62	4th	1.49	0.61
actively promote children's well-being and resilience in my (future) work context	7th	1.53	0.60	7th	1.52	0.59
effectively organise and plan environments for children and their families in my (future) work context	8th	1.60	0.73	8th	1.59	0.75
the key characteristics of a quality curriculum for young children	9th	1.68	0.85	9th	1.66	0.83
Area Two: Application of practical and professional skills through reflective practice - I think I am able to						
constantly reflect on and stay engaged in the systematic observation of my own practice with children	1st	1.45	0.61	1st	1.33	0.57
question and analyse concepts and understandings of national, regional, local or EU policies relating to children and young people	2nd	1.47	0.65	4th	1.86	0.74
successfully connect my actions to day to day practice with children	3rd	1.79	0.80	2nd	1.44	0.60
evaluate and further develop programmes to maximise the opportunities for effective engagement by children	4th	2.05	0.82	3rd	1.61	0.70
Area Three: Transferable skills - I think I am able to						
objectively assess my own effectiveness in working with children and their families	1st	1.35	0.54	2nd	1.30	0.51
effectively communicate my ideas in collaboration with other "players" in my local context	2nd	1.37	0.61	3rd	1.80	0.64
demonstrate my ideas in writing	3rd	1.87	0.85	1st	1.28	0.46

Comparison of Pre-Test and Post-Test

423 participants completed both the pre-test and the post-test questionnaires. The knowledge and skills questions were analysed using Wilcoxon matched pairs signed rank tests as shown in Table 3. In each case, the results are significant at the 0.01 level.

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Table 3. Wilcoxon results from the piloting pre-test/post-test questions

Area One: Knowledge and Understanding – I think I know how to	**Wilcoxon results**
actively promote health, safety and security at my (future) workplace while working with children	Z = -11.282,, p < 0.000
actively promote children's well-being and resilience in my (future) work context	Z = -12.125, p < 0.000
actively promote effective communication while working with children and their parents	Z = -12.165, p < 0.000
actively promote the development of children and young people in my (future) work context	Z = -13.53, p < 0.000
effectively organise and plan environments for children and their families in my (future) work context	Z = -13.266, p < 0.000
constantly develop my practice with children and their families through reflection and learning	Z = -12.277, p < 0.000
the key characteristics of a quality curriculum for young children	Z = -13.367, p < 0.000
make personalised provision for children taking account of their age and specific needs	Z = -12.771, p < 0.000
apply child-centred, rights-based approaches to working with children	Z = -11.532, p < 0.000
Area Two: Application of practical and professional skills through reflective practice - I think I am able to	
question and analyse concepts and understandings of national, regional, local or EU policies relating to children and young people	Z = -12.431, p < 0.000
evaluate and further develop programmes to maximise the opportunities for effective engagement by children	Z = -13.238, p < 0.000
successfully connect my actions to day to day practice with children	Z = -12.461, p < 0.000
constantly reflect on and stay engaged in the systematic observation of my own practice with children	Z = -12.353, p < 0.000
Area Three: Transferable skills - I think I am able to	
effectively communicate my ideas in collaboration with other "players" in my local context	Z = -11.833, p < 0.000
demonstrate my ideas in writing	Z = -13.65, p < 0.000
objectively assess my own effectiveness in working with children and their families	Z = -13.367, p < 0.000

Examining Differences Between Country and Profession

To examine whether there were any differences between how the questions were answered between countries with the *Tiny Oaks* environment, Kruskal Wallis tests were run. Although Profession had three categories (student, professional and other) there were very few responses for Other and so differences between Profession were also analysed using Wilcoxon matched pairs signed rank tests. The results are shown in Table 4 for both the pre-test and post-test responses. All questions show significant differences for country and profession at least at the 95% confidence level.

Usability

We were also interested in the usability of the simulated practice environment. According to Dillon (2001) usability is a measure of interface quality relating to the effectiveness, efficiency and satisfaction with which users can perform tasks with a software tool and usability evaluation is a fundamental aspect of user interface design. The post-pilot questionnaire includes a System Usability Scale (SUS) section. The SUS consists of 10 statements to be rated between "Strongly Agree" (5) and "Strongly disagree" (1). Five statements are positive (e.g., "*I thought the simulated practice environment was*

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Table 4. Differences Between Country and Profession

Area One: Knowledge and Understanding – I think I know how to	**Country**	**Profession**
	Kruskal Wallis results	**Wilcoxon results**
actively promote health, safety and security at my (future) workplace while working with children		
Pre-Test	$\chi^2(5)=70.562, p=0.000^*$	$Z=-11.148, p=0.000^*$
Post-Test	$\chi^2(5)=46.205, p=0.000^*$	$Z=-3.922, p=0.000^*$
actively promote children's well-being and resilience in my (future) work context		
Pre-Test	$\chi^2(5)= 60.911, p=0.000^*$	$Z=-11.110, p=0.000^*$
Post-Test	$\chi^2(5)=92.818, p=0.000^*$	$Z=-7.283, p=0.000^*$
actively promote effective communication while working with children and their parents		
Pre-Test	$\chi^2(5)=83.747, p=0.000^*$	$Z=-11.543, p=0.000^*$
Post-Test	$\chi^2(5)=83.922, p=0.000^*$	$Z=-6.664, p=0.000^*$
actively promote the development of children and young people in my (future) work context		
Pre-Test	$\chi^2(5)=58.538, p=0.000^*$	$Z=-11.650, p=0.000^*$
Post-Test	$\chi^2(5)=155.944, p=0.000^*$	$Z=-9.235, p=0.000^*$
effectively organise and plan environments for children and their families in my (future) work context		
Pre-Test	$\chi^2(5)=58.221, p=0.000^*$	$Z=-12.302, p=0.000^*$
Post-Test	$\chi^2(5)=162.621, p=0.000^*$	$Z=-9.063, p=0.000^*$
constantly develop my practice with children and their families through reflection and learning		
Pre-Test	$\chi^2(5)=55.841, p=0.000^*$	$Z=-8.557, p=0.000^*$
Post-Test	$\chi^2(5)=135.049, p=0.000^*$	$Z=-8.828, p=0.000^*$
the key characteristics of a quality curriculum for young children		
Pre-Test	$\chi^2(5)=64.960, p=0.000^*$	$Z=-11.959, p=0.000^*$
Post-Test	$\chi^2(5)=177.321, p=0.000^*$	$Z=-9.893, p=0.000^*$
make personalised provision for children taking account of their age and specific needs		
Pre-Test	$\chi^2(5)=64.552, p=0.000^*$	$Z=-11.905, p=0.000^*$
Post-Test	$\chi^2(5)=135.190, p=0.000^*$	$Z=-8.604, p=0.000^*$
apply child-centred, rights-based approaches to working with children		
Pre-Test	$\chi^2(5)=66.635, p=0.000^*$	$Z=-10.182, p=0.000^*$
Post-Test	$\chi^2(5)=154.963, p=0.000^*$	$Z=-9.243, p=0.000^*$
Area Two: Application of practical and professional skills through reflective practice - I think I am able to	**Country**	**Profession**
question and analyse concepts and understandings of national, regional, local or EU policies relating to children and young people		
Pre-Test	$\chi^2(5)=30.701, p=0.000^*$	$Z=-8.877, p=0.000^*$
Post-Test	$\chi^2(5)=119.127, p=0.000^*$	$Z=-5.763, p=0.000^*$

Table 4 continued on next page

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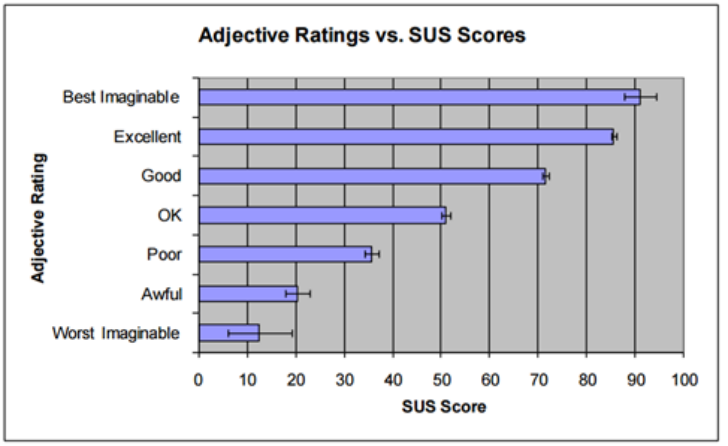
Table 4 continued

Area One: Knowledge and Understanding – I think I know how to	**Country**	**Profession**
evaluate and further develop programmes to maximise the opportunities for effective engagement by children		
Pre-Test	$\chi^2(5)=36.582, p=0.000$*	$Z=-9.213, p=0.000$*
Post-Test	$\chi^2(5)=125.656, p=0.000$*	$Z=-7.365, p=0.000$*
successfully connect my actions to day-to-day practice with children		
Pre-Test	$\chi^2(5)=79.024, p=0.000$*	$Z=-9.442, p=0.000$*
Post-Test	$\chi^2(5)=147.355, p=0.000$*	$Z=-8.510, p=0.000$*
constantly reflect on and stay engaged in the systematic observation of my own practice with children		
Pre-Test	$\chi^2(5)=71.140, p=0.000$*	$Z=-7.470, p=0.000$*
Post-Test	$\chi^2(5)=122.955, p=0.000$*	$Z=-6.201, p=0.000$*
Area Three: Transferable skills - I think I am able to	**Country**	**Profession**
effectively communicate my ideas in collaboration with other "players" in my local context		
Pre-Test	$\chi^2(5)=105.194, p=0.000$*	$Z=-6.218, p=0.000$*
Post-Test	$\chi^2(5)=147.239, p=0.000$*	$Z=-6.156, p=0.000$*
demonstrate my ideas in writing		
Pre-Test	$\chi^2(5)=40.699, p=0.000$*	$Z=-1.855, p=0.024$**
Post-Test	$\chi^2(5)=51.009, p=0.000$*	$Z=-2.187, p=0.029$**
objectively assess my own effectiveness in working with children and their families		
Pre-Test	$\chi^2(5)=51.697, p=0.000$*	$Z=-6.488, p=0.000$*
Post-Test	$\chi^2(5)=37.051, p=0.000$*	$Z=-0.136, p=0.021$**

* Significant at the 99% level; ** Significant at the 95% level

easy to use") and five are negative (e.g., "*I found the simulated practice environment unnecessarily complex*"), the questionnaire alternates between the two to avoid random answers. The scale includes a scoring system ranging from 0 to 100. Bangor, Kortum and Miller (2008) also propose a seven-point adjective rating scale for representing the computed SUS scores ranging from "*Worst imaginable*" to "*Best imaginable*" shown below.

Figure 4. Seven adjective ratings for a SUS score



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The mean SUS score across all participants in the piloting (n=360) is 87.03 with a median of 90.00 and a standard deviation of 11.74. According to the adjective rating scale, this corresponds to an "*Excellent*" score. The details for each group of participants are shown in Table 5 and can be seen that both experienced and inexperienced game players found the simulated practice environment highly usable. Perhaps not unexpectedly, the frequent game players found the game more usable than the less frequent game players.

Table 5. SUS score based on number of hours participants played computer games

Group	Mean	Median	SD	Adjective rating
Don't play computer games (n = 104)	82.45	85	12.20	Excellent
Occasional player (less than 1 hour per week) (n = 137)	87.74	90	10.58	Excellent
Medium player (1-7 hours per week) (n = 52)	85.63	88.75	13.06	Excellent
Frequent player (more than 7 hours per week) (n = 67)	93.77	95	8.58	Best Imaginable
TOTAL	**87.03**	**90.00**	**11.74**	**Excellent**

Table 6 lists all the SUS statements and, for each one, the number of participants who elected *Agree* or *Strongly agree*, the number of participants who selected *Disagree* or *Strongly disagree*, the equivalent percentages, the mean rating of the statement and standard deviation. The results are clearly overall positive with the vast majority (97.2%) finding the simulated practice environment easy to use and 98.9% wanting to use the environment again. A small number (2.8%) felt they needed support to use the environment.

Table 6. Participants' answers to the SUS questions

Statement	Participants agreeing	Participants disagreeing	Mean	SD
Positive statements				
I think I would like to use the simulated practice environment in the future	348 (96.7%)	8 (2.2%)	1.32	0.61
I thought the simulated practice environment was easy to use	347 (96.4%)	3 (0.8%)	1.42	0.59
I found the various scenarios and features of simulated practice environment well integrated	346 (91.1%)	1 (0.3%)	1.64	0.57
I would imagine most learners would be able to use the simulated practice environment very quickly	341 (94.7%)	3 (0.8%)	1.65	0.65
I felt very confident using the simulated practice environment	349 (96.9%)	3 (0.8%)	1.54	0.59
Negative statements				
I found the simulated practice environment unnecessarily complex	6 (1.7%)	340 (94.4%)	4.51	0.67
I think that I would need support to be able to use the simulated practice environment	15 (4.2%)	334 (92.8%)	4.42	0.76
I thought there was too much inconsistency in the simulated practice environment	5 (1.4%)	339 (94.2%)	4.58	0.66
I found the simulated practice environment very cumbersome to use	8 (2.2%)	340 (94.4%)	4.56	0.67
I need to learn a lot of things before I could get going with the simulated practice environment	12 (3.3%)	336 (93.3%)	4.32	0.70

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Some of the qualitative feedback obtained was as follows:

- "Visually very appealing game. Dialogue integrated really well. Feedback useful to know what you got right/wrong. Really good serious game".
- "This is a very good serious game and a cut above the majority of serious games I have played".
- "Good game ; very life-like; easy to use; would be useful in schools to give young people an idea of what a nursery is like".
- "Enjoyed the game and the graphics. My only criticism is that some additional content would have been useful as the game felt slightly short".
- "This is a nice looking game, easy to use. Even without much knowledge, I learned certain aspects of working with young children".
- "This really felt like being in a nursery and the environment and children were fantastic. Game was really easy to play but perhaps more content would have been useful as the game seemed quite short".
- "Having a 3D serious game is a big change from the usual 2D serious games, so this was a big step up and sets the game apart from many other serious games. Gameplay was quite fun, and graphics were great. More content would be useful and finding a better way to knit the scenarios together would also have been useful".
- "Difficult to fault, game looks amazing, game mechanics are good".
- "Really good serious game; one of the best I've seen; great graphics and very realistic setting".

Results for *Play2Do* Simulated Practice Environment

318 participants completed the **pre-test** questionnaire with 191 of the participants (60.1%) female and 127 participants (39.9%) male. The participants were from the UK and Bulgaria: 201 (63.2%) were from the UK and 117 (38.8)% where from Bulgaria. In terms of occupation, 208 (65.4%) of participants were in a relevant professional employment, 106 (33.3%) were students and 4 (1.3%) had a different employment status. The students had been in study for an average of 2.13 years (SD = 1.52) with a range of 0 to 6 years and the professional staff had an average of 10.48 years' experience (SD =6.5) with a range of 0 to 25 years. In terms of experience of computer games, 119 (37.4%) participants did not play computer games, 124 (39%) occasionally play (less than one hour per week), 60 (18.9%) play between one and seven hours per week and 15 (4.7%) were frequent game players (more than seven hours per week).

Three items measured for knowledge and understanding indicated a high level of internal consistency (Cronbach's $\alpha = 0.948$) and also for professional and transferable skills (Cronbach's $\alpha = 0.813$). In addition, the removal of each item resulted in a lower Cronbach's α indicating the importance of each item. Table 1 shows the mean, standard deviation and ranking for the participants' responses to questions relating to (1) their knowledge and understanding; (2) the application of practical and professional skills on their experience; and (3) transferable skills.

301 participants completed all the questions in the **post-test** questionnaire with 189 (62.8%) of the participants female and 112 (37.2%) participants were male. The participants were from the UK and Bulgaria with 192 (63.8%) participants from the UK, and 109 (36.2%) from Bulgaria. In terms of occupation, 191 (63.5%) of participants were in a relevant professional employment, 106 (35.2%) were students and 4 (1.3%) had a different employment status. The students had been in study for an average of 2.08 years (SD = 1.22) with a range of 0 to 6 years and the professional staff had an average of 10.07 years' experience (SD =6.42) with a range of 0 to 25 years. In terms of experience of computer games, 115 (38.2%) participants did not play computer games, 118 (39.2%) occasionally play (less than one hour per week), 54 (17.9%) play between one and seven hours per week and 14 (4.7%) were frequent game players (more than seven hours per week). Table 2 shows the mean, standard deviation and ranking for the participants' responses to questions relating to (1) their knowledge and understanding; (2) the application of practical and professional skills on their experience; and (3) transferable skills.

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Comparison of Pre-Test and Post-Test

301 participants completed both the pre-test and the post-test questionnaires. The knowledge and skills questions were analysed using Wilcoxon matched pairs signed rank tests as shown in Table 7. In each case, the results are significant at the 0.01 level.

Table 7. Wilcoxon results from the piloting pre-test/post-test questions

Area One: Knowledge and Understanding – I think I know how to	Wilcoxon results
actively promote health, safety and security at my (future) workplace while working with children	Z = -4.698,, p < 0.000
actively promote children's well-being and resilience in my (future) work context	Z = -6.593, p < 0.000
actively promote effective communication while working with children and their parents	Z = -4.573, p < 0.000
actively promote the development of children and young people in my (future) work context	Z = -6.971, p < 0.000
effectively organise and plan environments for children and their families in my (future) work context	Z = -3.078, p < 0.000
constantly develop my practice with children and their families through reflection and learning	Z = -6.738, p < 0.000
the key characteristics of a quality curriculum for young children	Z = -2.302, p < 0.000
make personalised provision for children taking account of their age and specific needs	Z = -7.492, p < 0.000
apply child-centred, rights-based approaches to working with children	Z = -8.010, p < 0.000
Area Two: Application of practical and professional skills through reflective practice - I think I am able to	
question and analyse concepts and understandings of national, regional, local or EU policies relating to children and young people	Z = -4.323, p < 0.000
evaluate and further develop programmes to maximise the opportunities for effective engagement by children	Z = -7.461, p < 0.000
successfully connect my actions to day to day practice with children	Z = -6.822, p < 0.000
constantly reflect on and stay engaged in the systematic observation of my own practice with children	Z = -8.726, p < 0.000
Area Three: Transferable skills - I think I am able to	
effectively communicate my ideas in collaboration with other "players" in my local context	Z = -5.658, p < 0.000
demonstrate my ideas in writing	Z = -11.844, p < 0.000
objectively assess my own effectiveness in working with children and their families	Z = -10.388, p < 0.000

Examining Differences Between Country and Profession

To examine whether there were any differences between how the questions were answered between countries for *Play2Do*, and differences between Profession was analysed using Wilcoxon matched pairs signed rank tests. The results are shown in Table 8 for both the pre-test and post-test responses. As with the *Tiny Oaks* evaluation, most questions show significant differences for country and profession at least the 95% confidence level. Exceptions were "*actively promote health, safety and security at my (future) workplace while working with children*" for profession (post-test only), "*evaluate and further develop programmes to maximise the opportunities for effective engagement by children*" for country and profession (pre-tests only), "*constantly reflect on and stay engaged in the systematic observation*

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Table 8. Differences Between Country and Profession

Area One: Knowledge and Understanding – I think I know how to	**Country**	**Profession**
	Kruskal Wallis results	**Wilcoxon results**
actively promote health, safety and security at my (future) workplace while working with children		
Pre-Test	Z=-7.318,p=0.000*	Z=-8.879,p=0.000*
Post-Test	Z=-2.694,p=0.007*	Z=-0.292,p=0.770
actively promote children's well-being and resilience in my (future) work context		
Pre-Test	Z=-7.614,p= 0.000*	Z=-8.609,p=0.000*
Post-Test	Z=-3.362,p=0.001*	Z=-5.050,p=0.000*
actively promote effective communication while working with children and their parents		
Pre-Test	Z=-5.768,p=0.000*	Z=-7.706,p=0.000*
Post-Test	Z=-2.589,p=0.010*	Z=-4.298,p=0.000*
actively promote the development of children and young people in my (future) work context		
Pre-Test	Z=-7.109,p=0.000*	Z=-8.795,p=0.000*
Post-Test	Z=-3.534,p=0.000*	Z=-5.902,p=0.000*
effectively organise and plan environments for children and their families in my (future) work context		
Pre-Test	Z=-5.184,p=0.000*	Z=-6.737,p=0.000*
Post-Test	Z=-3.572,p=0.000*	Z=-7.764,p=0.000*
constantly develop my practice with children and their families through reflection and learning		
Pre-Test	Z=-6.671,p=0.000*	Z=-7.420,p=0.000*
Post-Test	Z=-3.025,p=0.000*	Z=-5.968,p=0.000*
the key characteristics of a quality curriculum for young children		
Pre-Test	Z=-4.951,p=0.000*	Z=-4.426,p=0.000*
Post-Test	Z=-2.351,p=0.019**	Z=-8.806,p=0.000*
make personalised provision for children taking account of their age and specific needs		
Pre-Test	Z=-8.095,p=0.000*	Z=-8.591,p=0.000*
Post-Test	Z=-2.117,p=0.034**	Z=-6.829,p=0.000*
apply child-centred, rights-based approaches to working with children		
Pre-Test	Z=-7.453,p=0.000*	Z=-8.499,p=0.000*
Post-Test	Z=-2.341,p=0.017**	Z=-7.875,p=0.000*
Area Two: Application of practical and professional skills through reflective practice - I think I am able to	**Country**	**Profession**
question and analyse concepts and understandings of national, regional, local or EU policies relating to children and young people		
Pre-Test	Z=-1.551,p=0.121	Z=-2.399,p=0.016**
Post-Test	Z=-2.072,p=0.038**	Z=-7.803,p=0.000*

Table 8 continued on next page

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Table 8 continued

Area One: Knowledge and Understanding – I think I know how to	**Country**	**Profession**
evaluate and further develop programmes to maximise the opportunities for effective engagement by children		
Pre-Test	Z=-1.752,p=0.080	Z=-1.798,p=0.072
Post-Test	Z=-2.693,p=0.007*	Z=-6.777,p=0.000*
successfully connect my actions to day-to-day practice with children		
Pre-Test	Z=-6.355,p=0.000*	Z=-6.985,p=0.000*
Post-Test	Z=-2.273,p=0.023**	Z=-5.096,p=0.000*
constantly reflect on and stay engaged in the systematic observation of my own practice with children		
Pre-Test	Z=-6.392,p=0.000*	Z=-6.150,p=0.000*
Post-Test	Z=0.312,p=0.755	Z=-2.548,p=0.011**
Area Three: Transferable skills - I think I am able to	**Country**	**Profession**
effectively communicate my ideas in collaboration with other "players" in my local context		
Pre-Test	Z=-6.355,p=0.000*	Z=-2.673,p=0.008*
Post-Test	Z=-2.165,p=0.030**	Z=-5.786,p=0.000*
demonstrate my ideas in writing		
Pre-Test	Z=-0.463,p=0.643	Z=-0.467,p=0.640
Post-Test	Z=-1.447,p=0.148	Z=-1.862,p=0.063
objectively assess my own effectiveness in working with children and their families		
Pre-Test	Z=-4.720,p=0.000*	Z=-3.529,p=0.000*
Post-Test	Z=-2.691,p=0.006*	Z=-2.932,p=0.003*

* Significant at the 99% level; ** Significant at the 95% level

of my own practice with children" for country (post-test only), and "*demonstrate my ideas in writing*" for both country and profession (both pre-test and post-test).

Usability

The SUS usability questionnaire was also used for the *Play2Do* simulated practice environment. In this case, the mean SUS score across all participants in the piloting (n=301) was 86.50 with a median of 87.50 and a standard deviation of 7.53. According to the adjective rating scale, this corresponds to an "*Excellent*" score. The details for each group of participants are shown in Table 9 and it can be seen that both experienced and inexperienced game players found the simulated practice environment

Table 9. SUS score based on number of hours participants played computer games

Group	Mean	Median	SD	Adjective rating
Don't play computer games (n = 104)	83.80	85.00	8.64	Excellent
Occasional player (less than 1 hour per week) (n = 137)	87.90	87.50	5.63	Excellent
Medium player (1-7 hours per week) (n = 52)	87.13	87.50	6.84	Excellent
Frequent player (more than 7 hours per week) (n = 67)	94.46	96.25	4.83	Best Imaginable
TOTAL	**86.50**	**87.50**	**7.53**	**Excellent**

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highly usable. Perhaps not unexpectedly, the frequent game players found the game more usable than the less frequent game players.

Some of the qualitative feedback obtained was as follows:

- "I really enjoyed using this environment and it helped me reflect on my current practices".
- "This is one of the best serious games I have come across and it really covers a serious topic".
- "Excellent treatment of a very serious topic".
- "These scenarios helped me gain a better appreciation of what it will be like to work with vulnerable people once I graduate"
- "A very high fidelity simulation; best I have seen for this subject area".
- "This is a well produced game. My only minor criticism is that additional scenarios would have been helpful".
- "It's nice to see a serious game that's in my native language (Bulgarian). Most games assume everyone speaks English fluently".

CONCLUSION

This paper has discussed the background to the development of the *Tiny Oaks* and *Play2Do* 3D simulated practice environments for supporting people who work with vulnerable people. The literature shows that practice learning is a fundamental part of social work, social care and education, although there are recognised problems with availability and running of practice learning opportunities. Indeed, social work programmes have tried other approaches to preparing students for practice learning such as role play and use of trained actors. The approach proposed here is to use a dynamic 3D simulated practice environment to allow students to experience working with vulnerable people but without the difficulties associated with working in a real environment. It should be noted that we are not proposing this as a replacement for real-world practice learning *but* as a mechanism to augment it.

This type of professional learning provides rich opportunities for professionals and practitioners to develop and enhance their professional and propositional knowledge and practice. This, in turn, leads to continuous improvement in both professional practice and practice environments, as well as providing a vehicle for critical self-evaluation and assessment, being an important key component of professional learning and professional review, fundamental to the need for continuous professional development. This allows professional learners to best consider how they might develop their professional values, their professional/propositional knowledge, skills and understanding through ongoing critical self-evaluation and professional learning whilst expressing their learning while using these dynamic 3D simulated practice environments.

The paper has presented the results from piloting the two simulated practice environments across Europe. A pre-test/post-test methodology was employed to evaluate the two environments consisting of a fixed questionnaire that was given to participants before they used the environment and then after they had used the environment. The questionnaire consisted of 16 questions covering three areas: Knowledge and Understanding, Application of practical and professional skills through reflective practice, and Transferable skills. The first environment, *Tiny Oaks*, had 530 participants in the pre-test and 423 in the post-test from six European countries (UK, Bulgaria, Italy, Finland, Lithuania and Germany) and the results show a significant increase in learning across all 16 questions. The second environment, *Play2Do*, had 318 participants in the pre-test and 301 participants in the post-test from the UK and Bulgaria and, again, the results show a significant increase in learning across all 16 questions.

Data was also collected on the country the participant came from and the participant's profession (student or professional staff). For *Tiny Oaks*, all questions showed significant differences for country, and profession at least at the 95% confidence level. For *Play2Do*, again most questions showed significant differences for country and profession at least the 95% confidence level. Exceptions were "*actively promote health, safety and security at my (future) workplace while working with children*"

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for profession (post-test only), "*evaluate and further develop programmes to maximise the opportunities for effective engagement by children*" for country and profession (pre-tests only), "*constantly reflect on and stay engaged in the systematic observation of my own practice with children*" for country (post-test only), and "*demonstrate my ideas in writing*" for both country and profession (both pre-test and post-test).

The System Usability Scale (SUS) questionnaire was also used in the post-test to measure the usability of the environments and, for both *Tiny Oaks* and *Play2Do*, usability was found to be Excellent. These findings suggest that 3D simulated practice environments can provide a valuable learning experience and can provide practice learning scenarios that may be difficult to encounter in real-life.

The main limitation of this study is that participants were selected by project partners, including professional health and social care organisations, however, no control or experimental group was used. In the next study, we would aim to perform an experiment with participants randomly assigned to control and experimental groups, with the control group obtaining real-world practice learning and the experimental group just using the simulated practice environments.

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Conflict of Interest

The authors of this publication declare there is no conflict of interest. While a journal editor was a secondary author of the paper, additional independent blind reviews were carried out by the journal to avoid any conflict this might cause and one of the journal's Associate Editors made the final decision.

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Stephen Farrier, now retired, was a senior academic and Senior researcher of 35 years' experience. Stephen still remains active as consultant, advisor and, mentor within Higher Education, Public and private sector strategic levels. Stephen's research experience, as senior Academic adviser, Senior Research Fellow, educational consultant and senior lecturer, in Higher Education and professional education, within the area of abstracted learning, including pedagogy development and learning technologies. Stephen's other specialisms include, the study of professional practice, the sociology of professions, cultural competence and harmonisation, diversity, participatory democracy, knowledge architecture, skills acquisition, professional competence, artificial intelligence, assistive technologies, serious gaming architectures in education and learning. Stephen has developed and delivered many research based projects nationally and internationally, and is known for his credibility in these fields, as Principal Investigator, research manager, project manager. Stephen has published globally and has presented at many conferences and consultancies throughout his career.

Thomas Connolly, after 15 years in the software industry as a manager at Logica and a Director at SEMA, has been a professor for the last 30 years. He developed the first commercial relational database system in the world and went on to write the bestselling textbook Database Systems that has sold more than 2 million copies. He became Head of Computing and Information Systems at the University of Paisley (now University of the West of Scotland) and then Head of the Creative Technologies department. He led the computing research submission for both REF2008 and REF2014. In terms of research and commercialisation, Professor Connolly was Director of the Institute for Creative Technologies and Applied Computing (ICTAC), Director of the Clinical Decision Support Research Institute and Director of the Scottish Centre for Enabling Technologies (SCET). Professor Connolly has 25 PhD completions and over 300 peer-reviewed publications. He is editor of the International Journal of Virtual and Personal Learning Environments (IJVPLE) and peer reviews for many prestigious journals. In the last 15, he has completed over 650 national and international research and commercial projects.

Nikolina Tsvetkova, PhD, has long years of experience as a teacher trainer, course book author, researcher and English language teacher. Nikolina Tsvetkova is currently teaching ESP, intercultural communication, introduction to multilingualism in the EU and project terminology at the European Studies Department of Sofia University "St. Kliment Ohridski" where she is also involved in various teacher training activities. She has defended a PhD thesis in the field of Pedagogy and Intercultural Communication. She works in the sphere of language teaching, teacher training, intercultural communication, Europeanisation and internationalisation of education and applying ICTs in educational settings. She has written a number of papers, book chapters and a monograph on these topics. She is a member of the editorial board of the "Foreign Language Teaching" bimonthly journal issued by the Bulgarian Ministry of Education.

Mario Soflano is a lecturer in Applied Computer Games department at The School of Computing, Engineering and Built Environment at GCU. Prior to the current position, he was a lecturer in Computer Games programmes at University of the West of Scotland and he involved in a number of collaborative projects in Serious Games for professional trainings and in adaptive systems to improve operational process for SME clients. He led and successfully completed projects with Scottish Fisheries Museum Trust to create Augmented Reality for Increased Audience Engagement and Visitor Sustainability, Creating Financially Literate Generations for Passion4Fusion Ltd and Automatic 3D Avatar Generator in Mobile Device for IdeaSpring Ltd. As a co-investigator, he involved in immersive technology project for Scottish Crannog Centre, Application of Machine Learning for Little's Reservation System for Little's Chauffeur Drive, Smart Inventory System for Freezeshop Ltd and Smart email scheduling system for DragonByte Technologies. He also involved in location-based project for Glasgow City Council (2014-2015), Nursery Games to train nursery worker for SSSC (2014), NHS Clinical Decision Support System (2017 – 2020) and SAFER Maternity Risk Assessment NHS Education Scotland (2017). His PhD is in Adaptivity and Personalisation in Games-based Learning and his teaching responsibility focuses on programming in computer games development. His area of expertise includes 1) Serious Games to teach hard skills in various subject areas, such as STEM, Software Engineering, Languages and Health, and also to enhance soft skills such as motivations, leadership and teamwork / collaboration and 2) Adaptive System which includes Data analysis and Visualisation for Serious Games, eLearning, eCommerce and Software Engineering.

Petros Papadopoulos is an enthusiastic and highly motivated researcher in the field of Self-organising large distributed Autonomous systems. Always driven and passionate in innovation, usually through the mixture of existing and new technologies and/or methodologies, agile and aligned to business and user-centered requirements. In 2007, I received a full scholarship to complete a PhD in the field of self-organising systems. In the last few years, I had the opportunity to participate and contribute to a diverse range of cross-disciplinary research projects that helped me further develop a wide range of skills that helped me achieve and evolve my career goals and aspirations.