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An adaptation of the 'Escape Rooms' methodology in online learning to facilitate and investigate active learner-led activities and experiences.

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Abstract: This paper discusses the adaptation of 'Escape Rooms' methodology in online learning and investigates whether meaningful learner-led activities can be supported. The study has been built into an existing module at Coventry University, where students are expected to demonstrate study skills/competencies needed to analyse, employ, synthesise, and communicate evidence. The sampling was opportunistic, targeting students (n=13) who were already registered on the module. Microsoft Teams was selected as the online platform. This paper firstly discusses the design and development considerations, and secondly explores students' experiences using a multi-method approach to evaluate student engagement and competencies. The engagement aspects include the playful experience, perspectives on the approach, and gameplay strategy. Competencies associated with the learning objectives of the module include identifying a range of evidence types (scientific discovery and application, digital literacy) and interpreting information from a range of different evidence types (data interpretation, time management, problem-solving, exploring data). The target competencies also include communication and teamwork. The findings identify that co-created virtual escape room (VER) features enabled students to positively engage in the task leading to positive feelings about the experience. Students perceived that the VER enabled them to develop skills/competencies and knowledge, specifically problem solving and teamwork. The investigation highlights that online platforms not necessarily associated with playful experiences can be recontextualised to support meaningful learning experiences. The approach can be adapted on other platforms.

Keywords: online learning, playful learning, active learning, escape rooms, virtual escape rooms

1. Introduction

The pandemic presents a great challenge to teaching and learning globally. The immediate response has been the mobilisation of digital online learning to ensure remote education access at home. The sudden transition to technology-delivered instruction has been disconcerting for educators and learners alike. Varying levels of digital literacy and fluency amongst educators and students adds complexity to proceedings including familiarisation with functions and access to learning resources. The pandemic requires agile and exploratory responses when it comes to the transition into digital teaching and learning, and a shorter learning curve.

One of the main challenges posed by this is whether meaningful learning experiences can still be facilitated on online platforms. Putting learners at the heart of the agenda, it is essential to ensure that their learning experiences are configured and reconfigured as and when it is needed for supporting their growth in their learning process, aligning with the 'hybrid learning' perspective. "With the perspectives of learning at the speed of need across different spatial, contextual, and material modalities, and the blending of these modalities, hybrid learning proposes a more pragmatic and holistic approach for finding the right combination out of all modalities, whether they are offline or online, digital or analogue, passive or experiential, formal or informal…" Arnab (2020, p. 40).

The configuration of learning experiences can take inspiration from playful activities, which often promote agency, autonomy, experimentation, and exploration. Playfulness as a characteristic of hybridity in open

education relies on the value of joy, creativity, curiosity, exploration, and experimentation in learning to promote agency and autonomy (Dalsgaard et al., 2017). Play enables experiential practices for constructing knowledge and skills (Winthrop, 2019), facilitating a creative inquiry process (Nørgård et al., 2017) through social constructivism (Gee, 2016). Constructivism suggests that individuals learn through active exploration not passive reception, and that learning occurs within a social context between learners and their peers.

Active learning occurs through playful activities creating powerful learning environments (Iacovides et al., 2011). Using games as a playful tool allows learners to engage in imagined scenarios and challenges that could also be collaborative, "defined by rules, that results in a quantifiable outcome" (Salen & Zimmerman, 2008). Gameful learning scenarios that learners can traverse through as part of their learning experience have the potential to promote transferability of the metacognition process into practices in their day to day lives, including their formal education, informal learning, and social interactions. A metacognition process is "…a reflective process, where learners constantly monitor and evaluate their progress during problem solving. Learners can reflect on whether their current level of understanding is sufficient, often occurs in formal and informal settings throughout their lifetime" Arnab (2020, p. 6), nurturing intrinsic motivation in the learning process. Such motivation to solve problems often links to the concept of 'hard fun" (Lazzaro, 2004), where engaging with optimal challenges towards experiencing mastery leads to positive engagement in problem solving activities. The need for competence often leads learners and players alike to "seek challenges that are optimal for their capacities and to persistently attempt to maintain and enhance those skills and capacities through activity" (Deci and Ryan, 2004; p. 7).

Acknowledging that playful activities enable experiential and active learning to happen, this paper discusses an adaptation of a playful experience based on the 'Escape Rooms' methodology on an online platform and investigates if such adaptation could support learner-led activities. The research was built into an existing module at Coventry University – '4006SPO: Study skills and insights into research in coaching'. This paper described the co-creation process with the two module leads, the design choices, and the quantitative and qualitative findings related to the aspects of engagement and competencies.

2. Escape Rooms and Learning

Escape Rooms are "live-action team-based games where players discover clues, solve puzzles, and accomplish tasks in one or more rooms in order to accomplish a specific goal." (Nicholson, 2005). These experiences have grown in popularity worldwide, with rooms available across most continents including Europe, America, and Asia. Players are immersed in narratives as they solve various challenges presented to them in the rooms, where the narratives are often formed around mystery and mystery solving, setting the games atmosphere and laying the foundations of emotional investment and curiosity with players.

Mystery has also been used as an educational motivator and existing studies show that its introduction produces positive effects. Duncan et al. (2018) tested an approach around the mystery aspect and problem-based learning. The goal was to encourage postgraduates to be more curious, engage with each other, and most importantly, to carry out additional inquiries intrinsically beyond the formal scope of the course.

Educators are increasingly inspired to adapt escape room games with mystery and curious aspects into various areas of education (Cable, 2017; Clarke et al., 2017; Nicholson, 2018) as a method to develop playful and productive failure techniques for encouraging continuous development (Whitton, 2018). A systematic review carried out by Fotaris and Mastoras (2019) highlights their positive impact on student motivation and soft skills development such as teamwork, creativity, decision-making, leadership, communication, and critical thinking, and emphasises the enjoyable experience that immerses students as active participants in the learning environment. Clarke et al. (2017) repurposed the Escape Rooms methodology for education into a more hybrid experience called 'escapED'. This consists of a collection of educational puzzles that blends the use of digital and physical artefacts spread across two separate physical locations (rooms). The 'game' was highly dependent on the interaction between the players in both rooms, where they can only communicate via 'Skype' in order to collectively solve the mystery, demonstrating a potential for a remote setting. There now exist various online escape rooms that are on offer for mainly entertainment purposes, such as 'The Go Game', 'Escape Live', and 'Virtual Escaping'. There are also authoring tools that enable anyone to create online escape rooms, where the different "rooms" are often represented by more than 2-dimensional representations (see 'Room Escape Maker').

The Escape Rooms methodology provides a playful foundation for learning experiences to be designed into a more contextualised manner. Using narratives and mystery could invoke the much-needed curiosity and motivation to be persistent on problem solving.

3. Methods and Materials

The aim of study is to investigate whether the adaptation of 'Escape Rooms' methodology in online learning could support learner-led activities. It has been built into an existing module at Coventry University where students are expected to demonstrate study skills/competencies needed to analyse, employ, synthesise, and communicate evidence. The objectives included: (1) to design virtual escape rooms (VERs) to support students' development of study skills/competencies needed to analyse, employ, synthesise, and communicate evidence, and (2) to explore learner experiences of the co-designed VERs using a multi-method approach.

The sampling was opportunistic, targeting students (n=13, 18 ± 0 years) who were already registered on the module. Students' prior educational experiences included international (n=2), vocational BTEC (n=4) and a mixture of academic A levels and vocational BTEC (n=7) post 16 Further Education qualifications. Microsoft Teams was selected as the online platform as it is the most common platforms used for engaging with students at the University, especially during the pandemic. Ethics approval has been received for this study.

3.1 Co-design of the virtual escape room (VERs)

The iterative design process was based on Arnab and Clarke (2017)'s transdisciplinary game design approach, where the subject experts, researchers, and designers collaborated in the development of the mechanics, dynamics, and aesthetics (MDA) of the VERs. The pragmatic approach centred around the key learning objectives that the activities were aiming to facilitate and achieve, which subsequently informed the MDA and the practical manifestations of VERs resources including narratives and puzzles. Figure 1 demonstrates the logic flow of the VERs with Microsoft Teams.

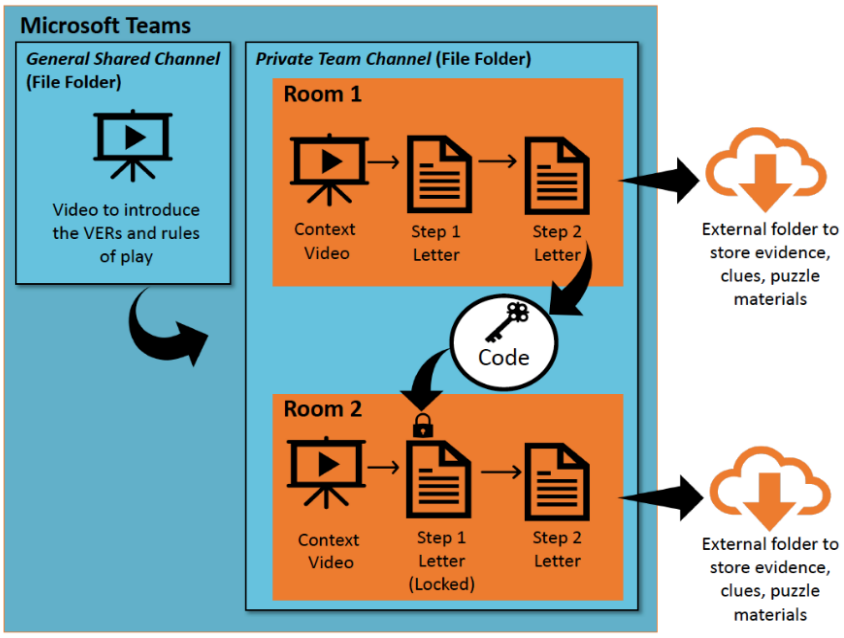

Figure 1. VERs Microsoft Teams Edition 1.0.

The pragmatic approach also responds to the hybrid learning perspective on configuring experiences that are empathic to the status quo. The (regular) context of use of the platform was considered in the design, where its relevant functionalities formed the enablers of the VERs' MDA. For instance, the 'channels' represented the specific learner groups, the 'folders' represent specific rooms, and the conferencing (team meeting) function would be the main communication channel. Students are often required to access documents external to the platform, such as the Microsoft OneDrive. This aspect was also included in the design. As part of the transdisciplinary game design approach, each learning objective was mapped against the MDA of the VERs based on the Learning Mechanics - Game Mechanics Mapping (LMGM) model (Arnab et al., 2015). Table 1 demonstrates the example mapping for Room 1.

Table 1. The mapping of learning objectives to the mechanics of the VERs (Room 1)

Learning Objective	Room Mission	Learning mechanics	Game Mechanics	Room Artefacts (Aesthetics)	Content (Videos and Letters)	External Folder Materials
To be able to assess the reliability of multi-sources evidence and extract correct information	What is the new and unusual injury that the radiologist is worried about?	Instructional Understand Discover Interpret	Cutscene Narrative Mission Role-play	**Video**: To set the context for the mission **Aesthetics**: Dr. Dwek FaceTiming the coaches	**Video script:** Hello and welcome to my practice. I am Dr. Dwek, a radiologist. It is great to meet all you coaches but I need your help. In the last month I have had gymnast after gymnast attending my practice with injuries. These are not like the usual injuries I see. They are new and unusual, I am worried that you are putting your athletes at risk for injuries that are going to ruin their career and their future. I think it might be possible that if we work together we could fix this. I have left you some of the information I have been working on. See if you can crack the codes in these to help us find the answer. In the first folder of evidence, I need your help in working out what these new and unusual injuries are. I have also left you letters/my notes and the files I have been looking at to help you.	N/A
		Interpret Plan Questioning Hypothesis Testing Reflecting Collaboration	Action Points Clues Puzzles Mission Collaboration Communal discovery	**Step 1 Letter**: Evaluating Evidence **Answer**: Distal Radial Physis	Dear Coaches, In my files for Step 1, you will see all the evidence I have been looking at. I need your help to work out what files have relevant information about the specific injury and which ones are irrelevant. I think if you then look at just the relevant evidence, it might have some specific information about the specific injury I am finding. I am looking for the name it might be called. I think other people might have found this type of injury before. You can access the secret files here: LINK. Best of Luck Dr. Dwek	**Research paper:** abstract Ashwell. Identifies 'injury of the distal radial physis (gymnast wrist) **XRAY:** Image of gymnast wrist damage (e.g. to radial ephyseal plate) **Athlete profile:** no information on the injury **URL:** https://www.nhs.uk/conditions/sports-injuries/
		Problem solving Testing Reflecting Collaboration	Action Points Puzzles Collaboration Communal discovery	**Step 2 Letter**: Crack the code **Code**: using the abbreviation – RDP, the code will be 38.	Dear Coaches, I have some information for you all but due to GDPR laws, I'm having to leave this information with you in a number format. So, in order to get through, you'll need to crack the code in Step 2. You can find this zipped folder in Room 1 as 'Room 1 Step 2'. Apologies for the lack of guidance with this, but I'm sure that you all more than capable. You can access the secret files here: LINK. Best of Luck Dr. Dwek	**Clue 1:** a riddle - 'what matters is no other position but first. First place is the only place with value' **Clue 2:** definition of acronym **Clue 3:** Code breaker – a set of alphabets and their values. With a simple instruction – ADD ME.

Both Microsoft Teams and OneDrive were used when implementing the VERs. A new team was created with two different kinds of communication channels, a public channel (also known as the general channel where everyone begins), and one or more private team channels in which participants were grouped. Participants first joined the general channel. The facilitator briefed and showed learners an introduction video summarising the rules of play. They were then directed to their private channels where they entered the VER in their assigned groups. Each group had access to their own folders (Room folders – see Figure 3) which allowed them to work without interference from other teams, also introducing competition, i.e., who can escape the quickest. In each room folder, students in their team accessed a mission video and two mission letters labelled as 'Step 1' and 'Step 2'. These created a wider narrative to the scenario that was being investigated, providing a mission for the group. The letter included an external link to a OneDrive folder. Groups had to explore the evidence and clues accessed via the external links to solve the mission set in the Step 1 letter and follow the next steps to crack the code in Step 2 to unlock the next room's Step 1 letter. Each room had a facilitator.

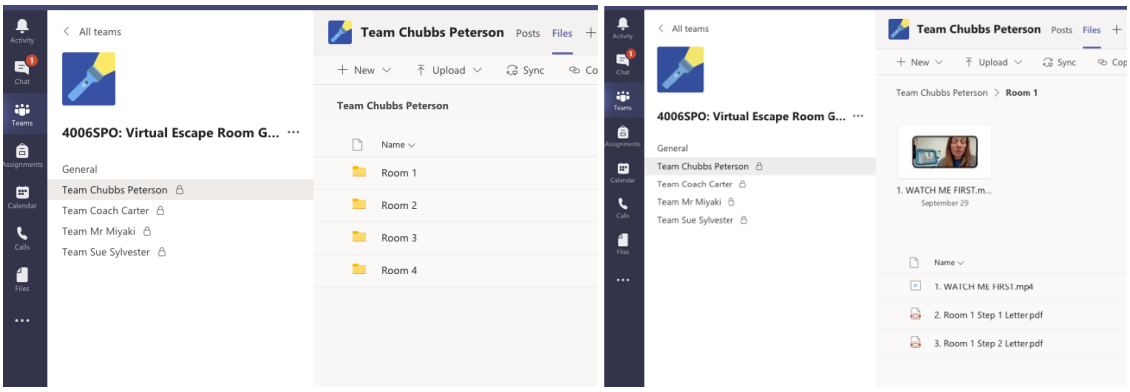

Figure 3. Each team accessing the room folders

Group members collaborated using voice or video conferencing. One learner was recommended to share their screen so the group could see the folder contents collectively. Once a group formulated an answer to Step 1's mission, they advanced to Step 2 which tasked them to solve the new mission puzzles to unlock the next room in the activity. The mission prompts in each step of a room were connected so group members might find the need to backtrack and review clues they might have missed to solve the code. Facilitators had the ability to join the private team channels in order to assist if necessary.

3.2 Evaluations

The research design was quasi-experimental, targeting students who were already registered on the specific module. Quasi-experiments are often conducted to evaluate the effectiveness of an intervention. Since the study was restricted by the delivery of the specific module, we used non-equivalent 'Combination Designs' to gain insights on the changes or improvements that have occurred. A multi-method design was used to address Objective 2 using a parallel approach. This enables the investigator to collect and analyse data which integrates the findings, drawing inferences using both qualitative and quantitative approaches. The parallel approach enables the quantitative and qualitative data to be collated separately but triangulated at the finding stages (Östlund et al., 2011). A detailed overview of the purpose of these approaches, the priority, and importance of the findings produced by each method and how that informs the conclusions is provided in Figure 4, in line with recommendations from Creswell & Plano-Clarke (2007).

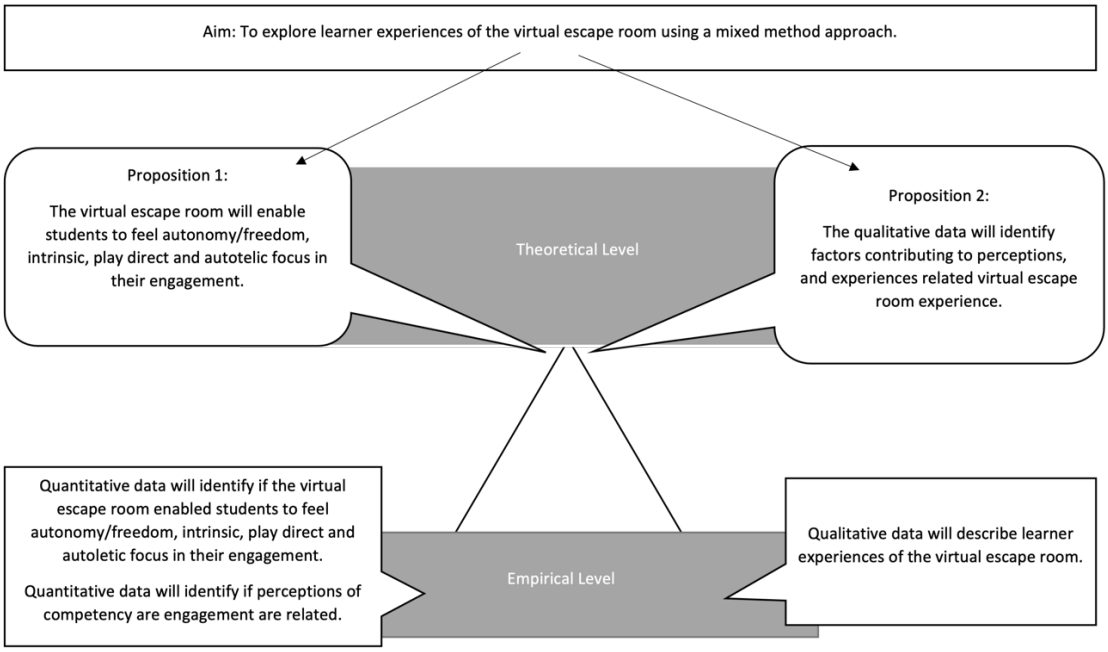

Figure 4. Illustration of the use of triangulation on complementary results based on the work of Ezerberger & Kelle, (2003) and Östlund et al., (2011).

Quantitative elements included assessments of engagement and perceived competencies. The engagement aspects were based on the playful experience scale developed and evaluated by Pavlas et al. (2012) that suggests four key elements: freedom (autonomy), intrinsic motivation (no external influences), play-direct (activities feels like play), and autotelic-focus (engagement with activities being the actual reward). There were 4 statements corresponding to each element, associated with 5-likert scale ranging from 1 (highly disagree) to 5 (highly agree). The competencies aspects were associated with the learning objectives of the module, which include identifying a range of evidence types (scientific discovery, digital literacy), interpreting information from a range of different evidence types (data interpretation, time management, problem-solving, exploring data), and teamwork. There were 24 statements associated to 5-likert scale ranging from 1 (no confidence) to 5 (very high confidence). The statements for both playful aspects and competencies audit are as listed in appendices 1 and 2 respectively. All quantitative scales were analysed in excel for frequency of responses, sum of frequencies for domains, mean, and mode. Associations between scale domains were assessed using Spearman's correlations in SPSS, in line with propositions set in Figure 4. *P* was set to 0.05 a priori.

Qualitative feedback was collected through the reflection pieces that the students developed as part of their module assignments. Reflective writing pieces were analysed using data driven thematic analysis with the guidelines proposed by Braun & Clarke, (2006). Thematic analysis is a widely used analytical process which is used to identify, analyse and explore patterns in qualitative data (Braun & Clarke, 2006).

On completion of quantitative and qualitative data analysis methods, triangulation was used to identify similarities and differences between data types and provide a greater understanding and depth to responses, in line with Figure 4.

4. Findings

4.1 Playful experience

In relation to proposition 1, the mean for the categories of the Playful Experience Scale demonstrated values towards the higher scale except for Play-Direct with a mean of 2.76, compared to Autonomy (3.28), Intrinsic (3.58), and Autotelic Focus (3.48). This suggests that a positive level engagement was achieved even though the VER was perhaps not associated to play by the participants. The majority of responses on Play-Direct statements were 'disagree' or 'neither agree nor disagree', highlighting that students were unable to make a decision about whether the VER felt like play. The full quantitative data is presented in Appendix 1.

Further analysis found that Statements 4.1 and 4.3 (corresponding to Autotelic Focus) had low standard deviation values indicating participants' agreement about being focused and wanting to do well with the responses clustering towards the high 3.5. There was a correlation between Statement 4.1 (wanting to do well) and 2.2 (knowing there would be no real-world consequences corresponding to Intrinsic). This suggests that the low stakes nature was connected with wanting to do well, highlighting that intrinsic motivation was a key driver. The analysis also showed that Statement 1.1 (corresponding to autonomy) correlated with both 4.1 (focused on the task at hand) and 4.3.

Strong correlations between 2.1, 2.2, and 2.3 (all corresponding to Intrinsic), and between 1.1, 1.2, and 1.3 (all corresponding to autonomy) suggests that the engagement with the VER activities were not motivated by outside pressure and a certain level of autonomy was experienced by the participants. There were also correlations between 2.1 and 2.2 and 4.1 (focus) indicating a relationship between being focused and no external pressure.

4.2 Competencies audit

Perceptions of competency were mixed across the student group. The quantitative data is presented in Appendix 2. Following completion of the VER, the majority of responses fell within the 'moderate to high level of competence' or 'very high level of competence' for time management, teamwork, and problem solving. For scientific discovery, digital literacy, and data interpretation, the findings were more mixed with the majority of responses falling across 'average, moderate and very high'. For scientific discovery, the majority of students scored themselves within the 'average level of competence' for half the questions with the domain. Yet, for the question within the domain asking about their confidence in sharing findings from scientific resources, 10/13 students rated themselves moderate to high level of competence and confidence. For searching for scientific articles this varied from average to moderate. Data interpretation had more students rating themselves as average than other competencies. Specifically, the statement associated with 'the ability to evaluate data, information, digital content in terms of quality and relevance' had 3/13 rating themselves as low competence. For digital literacy a similar pattern was true with statements related to 'synthesising data from multiple sources to provide useful insights and findings' and 'communicating findings from data they had accessed'.

4.3 Associations between playful experience and competency

Of all the playful experience domains, Play-Direct was more strongly positively associated ($P<0.05$) with all six competencies (i.e., teamwork (r=.904), data interpretation (r=.819), problem solving (r=.815), scientific discovery (r=.754), time management (r=.683) and digital literacy (r=.576). Autonomy/freedom was positively associated with 5 out of 6 competencies (i.e., digital literacy .730, data interpretation (.738), time management (.612), scientific discovery (.578), problem solving (.585). Intrinsic was only positively associated with 3 out of 6 competencies (i.e., problem solving (r=.710), scientific discovery and digital literacy (r=595, .593). Autotelic focus was positively associated with scientific discovery (r=.661), problem solving (r=.710) and teamwork (r=.659).

4.4 Analysis of reflections from learners

Six main themes were identified (feelings, facilitators to task completion, challenges to task completion speed, strategies developed to overcome challenges, development of skills and knowledge, individual factors) with several sub themes and overlapping areas. The example thematic mapping is illustrated in Appendix 3. All students had positive emotions about the experience (n=13) with competition (n=4), group task (n=8) and the novel experience (n=5) being facilitators to task completion and resulting in positive feelings about the experience. The escape room experience was perceived to result in the development of skills and knowledge which had three sub themes i.e., transferable skills (n=14), study skills (n=9) and gaining knowledge (n=9). Students identified three sub themes which resulted in challenges to task completion speed, these were technology (n=7), teamwork at the start (n =7) and getting to grips with the task (n=4). Improving teamwork (n=7), using other technology features (n=4) and referring back to task instructions (n=2) were common strategies developed to overcome these challenges with teamwork identified as the main action to improve further should the task be repeated. Language barriers (n=3) and low self-confidence (n= 5) were identified as key sub themes related to individual factors that impacted on teamwork.

4.5 ***Triangulation***

A summary of the key findings from both methods is presented in Figure 5. The VERs were synonymous with developing skills and knowledge, specifically, teamwork and problem solving. Quantitative analysis highlighted teamwork and problem solving as the strongest competencies following the escape rooms which students felt

were developed by the task. Qualitative data supports the development of these skills with students discussing how the VERs facilitated the development of teamwork and problem solving. For problem solving, students explained in their reflections that the VER enabled them to think, explore, make decisions, think on their feet/outside of the box and develop strategies to overcome challenges. It was further explained that at the beginning of the VERs, teamwork was inhibited due to poor communication, working independently on the task and poor group cohesion. During the VERs, they had to develop these areas to enable them to complete the task and thus identified how improving their team working skills, referring back to task instructions and problem solving were strategies they developed to compete the task. This was further developed by the ability to do a second room, which they felt was smoother due to their experience. A student explained *'During the first escape room this was something that was new to all of us this resulted in that at the start we were slow and didn't really understand effective ways to do the tasks at hand. We also me and another student faced some technical difficulties meaning that we slowed the pace of tasks down. We all were going through all the files separately and discussing the information however this resulted in all of us ending up on different pages once again slowing us down. Therefore, during the second escape room one student shared their screen on teams meaning that we were all on the same page, causing us to be faster all combining to uses our problem-solving skills due to this it felt a lot smoother and easier to find the information and complete the tasks we had'.*

Another student reported '*The escape room allowed us as a group to research and dig deep into parts of documents and text to find clues and answers to allow us to progress into the next stages. You had to pay close attention to all parts of the articles to make sure you inherited the most useful and correct information. In relation to researching information about your own work it has opened up to me how important being selective and steady with the text can be. Some part of the article's information was completely irrelevant to the escape room task therefore just needed to be quickly read and left. However, the important text needed to be selected and pieced together to form a solid and fluent answer. This is similar when researching your own information needed that you need to be selective and piece parts of information together from different articles to form a piece of work that is at a high informative standard'.* Furthermore, low self-confidence and language barriers were linked to poor teamwork at the start. The qualitative data showed that for some individuals they were worried about sharing their knowledge out of fear of getting wrong, thus impacting on the group dynamics, teamwork. Furthermore, students identified how they were in the 'getting to know each other' phase and how not knowing each other impacted on their teamwork. Students shared *'on a personal note I was quite quiet this is because I'm the type of personal if I am unsure on the answer to the question, I will just not say anything. However, after completing the exercise, I have realised that getting the answer wrong isn't always a bad thing as this can then help lead you towards the correct answer that you need to get'*. A student further explained *'The reason for this is that we could be not so confident in our answers meaning that we could feel like it could be wrong and do not want to embarrass ourselves with the wrong answers, this could mean that we do not feel embarrassed when giving out the wrong answers in front of the group'. This* was supported by quantitative data which identified that perceived academic self-efficacy was most strongly related with competencies not social self-efficacy.

Mixed findings about competency with digital literacy was found from the questionnaires and this was further explained in reflections. Some students identified (n=5) a development in their digital skills connected to multi-tasking across technology and their use of functions (e.g., share screen and chat). For others, technology was identified as a challenge (n=7) to task completion due to having to navigate several tabs, working with teammates with technical difficulties, and accessing information and files. For some students these issues caused negative emotions (frustration, annoyance) but they found ways to overcome these. A student shared *'Two of the people in the group could only type in the chat box and the other person couldn't see the chat box as he was sharing his screen for us to see, so this made it important for me to read everything those typing in the chat and pass on the different ideas and thoughts that they had to the Joel who was sharing his screen. '*

For engagement in the task, students' responses indicated 'neither agree or disagree' or 'agree' for autonomy/freedom, intrinsic, and auto-telic focus. These responses may have been impacted by their roles in the group dynamic (some being leaders, some observers, i.e., those with language barriers or technology difficulties). A student reflected on their language challenges *'in my group, I was not able to participant in group activity. I just looked what another classmate did and tried to catch what they were speaking each other. So, now I have to get used to new environment and their English live especially speaking and listening. I felt difficulties with language barrier, so to improve engagement, I should say 'can you speak slowly please?' And 'can you rephrase that for me please?' to communicate with other participants*. The reflections further identified that the main facilitators of the task were competition, group task, and the novel experience, these factors were also

shown to result in positive emotions from the experience. Students reported 'the competitive side of the room drove me through as I wanted to win'.

Finally, quantitative data illustrates that most participants disagreed that VERs were play. The exploration of student perceptions identified students experience of the VERs resulted in the development of skills and knowledge, specifically content knowledge and problem-based learning, learning from others, and was quite challenging to begin with. This may have impacted on the play-direct. The difficulties faced may have impacted on their perception of playful elements, requiring a lot of attention/focus to content. A student shared *'we needed to think outside of the box and work together as a team to solve the puzzles. It was also very educational as the topics that we were investigating were similar to the content that we need to learn on the sports coaching course. This made it feel more worth-while and the experience was very enjoyable for me'.* It was apparent that for some individuals the task was a struggle that was made easier by learning through the group task e.g., learning from others. A student shared *'I enjoyed it a lot as I got to learn from others and improving my own performance in the search analysis to complete each task'*. A student also shared *'I searched and read in many different sources and so I lost more time without realizing that everything we need is in front of my eyes. It was interesting for me because I learned some new and very important things that I would not consider by myself, but it is really important because as long-time active athletes and future coaches we need to know everything about injuries and how we can avoid them. Last week's search strategy and skills were the most important and the key things to solving problems and finding answers to get out of the Escape room'.*

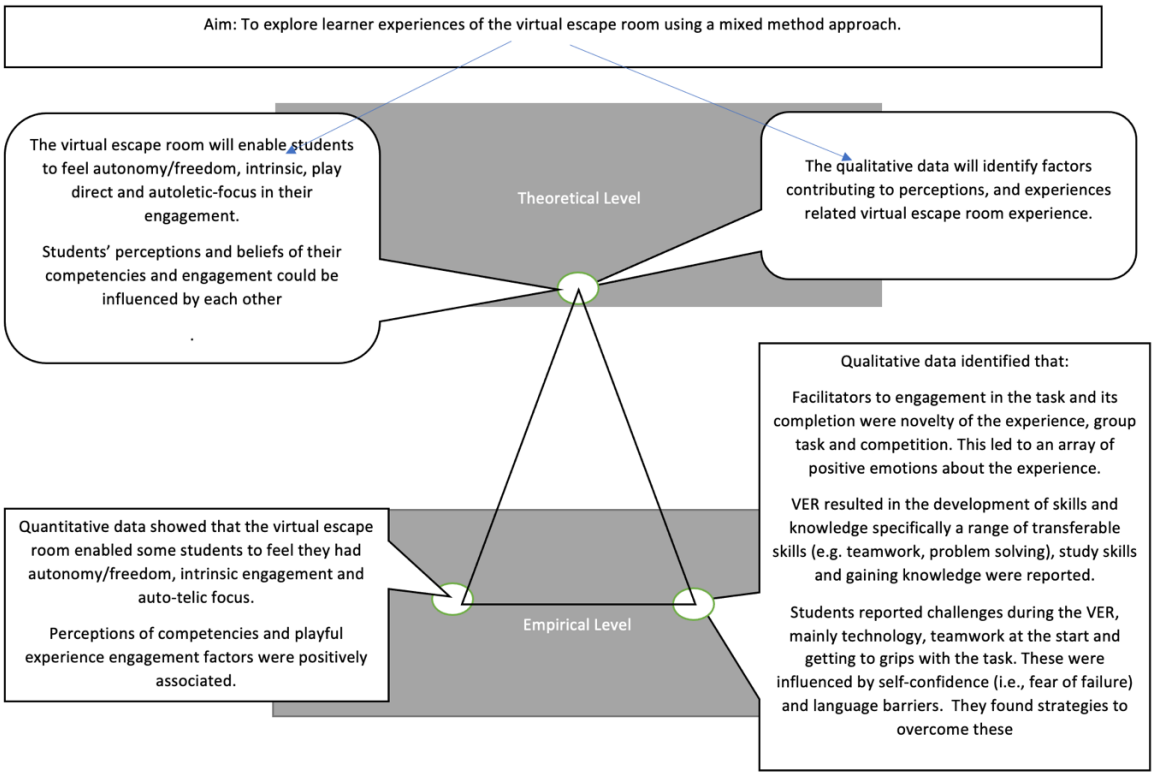

Figure 5. Illustration of the use of triangulation on complementary results based on the work of Ezerberger & Kelle (2003) and Östlund et al. (2011).

5. Conclusions

VERs are a meaningful learning experience for students in the development of skills and knowledge, without Play-Direct. The design of the VERs consists of the competitive elements where students working in their teams and competing to exit the rooms the quickest. The narrative elements and the problem solving were the mechanics for levelling-up from one room to another, engaging with serious contents. The VERs were not immediately considered as 'play' by the students. However, the playful aspects such as autonomy, autotelic focus and so forth were demonstrated, aligning with the intrinsic nature of playful activities.

Multiple factors influence these experiences, providing varied responses in the development of competencies due to group dynamics and roles, competencies, language barriers, self-efficacy and challenges faced. Specifically, VER provides a unique learning opportunity for problem solving in a supportive team task and an opportunity to put into practice actions learnt from the first experience. To foster the richest learning environment for all, educators should consider these factors when designing VERs and allocating groups. Further research should examine the transferability of the development of these competencies to attainment.

6. Acknowledgement

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Appendix 1 Table Frequencies for engagement in playful experiences questions and sum of frequencies for domains of playful experiences in University students (n=13)

Playful Experience questions/**domains**	Highly disagree	Disagree	Neither agree nor disagree	Agree	Highly agree
1.1 If I wanted to do something in the VER, I was able to do it	0	1	***7***	4	1
1.2. I was able to make use of the resources in the VER as I wanted to	0	2	4	***6***	1
1.3. The VER gave me the freedom to act how I wanted to	0	2	3	***6***	2
1.4. The VER made it difficult to perform the actions that I wanted to	0	3	***4***	***4***	2
Autonomy/freedom	**0**	**8**	**18**	**20**	**6**
2.1. I was not worried about someone judging how I performed in the VER.	0	1	5	***6***	1
2.2. Regardless of how I performed in the VER, I knew there wouldn't be a real-world consequence.	0	1	4	***5***	3
2.3. My performance in the VER was not going to matter outside of the game.	0	0	4	***7***	2
2.4. I felt like I had to do well, or the facilitators would judge me.	2	3	***5***	2	1
Intrinsic	**2**	**5**	**18**	**20**	**7**
3.1. When I was using the VER, it felt like I was playing rather than working.	0	***6***	4	3	0
3.2. I would characterise my experience with the VER as playing.	1	***5***	***5***	2	0
3.3. I was playing a VER rather than working.	0	4	***6***	3	0
3.4. Using the VER felt like work.	0	2	***6***	4	1
Play-Direct	**1**	**17**	**21**	**12**	**1**
4.1. When I was using the VER, I was focused on the task at hand.	0	1	***6***	***6***	0
4.2. I wanted to do well in the VER, "just because".	0	2	***6***	4	1
4.3. When I was using the VER, I wanted to do as well as possible.	0	1	4	***8***	0
4.4. I tried to succeed in the VER because I felt like it.	0	1	5	***6***	1
Autotelic Focus	**0**	**5**	**21**	**24**	**2**

footnote: mode in italic

Appendix 2 Table. Frequencies for competency questions and sum of frequencies for competency domains in University students (n=13)

Competency **domains**/questions	No competence, no experience, no confidence	low competence , limited experience, lacks confidence	average level of competence, some experience in skill area, some confidence	moderate to high level of competence, good experience of skill area, confident	very high level of competence, extensive experience, very confident
1.1. I am confident in understanding scientific resources in my study.	1	0	***8***	3	1
1.2. I am aware of the different types of scientific resources.	0	1	***7***	4	1
1.3. I am confident in searching for scientific articles	1	2	***5***	**5**	0
1.4. I am confident in sharing my findings from scientific resources.	0	3	*4*	**6**	0
1. Scientific Discovery	**2**	**6**	**24**	**18**	**2**
2.1. I am confident in interacting with digital technologies.	0	2	*3*	**6**	2
2.2. I am confident in collaborating through digital technologies.	0	2	*4*	**5**	2
2.3. I am confident in sharing through digital technologies.	0	3	***4***	**4**	2
2. Digital Literacy	**0**	**7**	**11**	**15**	**6**
3.1. I am able to evaluate data, information and digital content in terms of quality and relevance.	0	3	***5***	4	1
3.2. I am able to synthesize data from multiple sources to provide useful insights/findings.	0	1	***7***	5	0
3.3. I am able to communicate findings from data I have accessed.	1	1	***6***	5	0
3. Data Interpretation	**1**	**5**	**18**	**14**	**1**
4.1. I am able to identify problems that need to be solved in a project.	0	1	5	**6**	1
4.2. I can identify materials, resources and tools to help me solve problems.	1	0	5	**7**	0
4.3. I am confident in analysing aspects of a problem towards developing solutions.	0	2	5	**6**	0
4.4. I often use strategies, tools I learned and subject-	0	1	6	**6**	0

area knowledge to solve problems.					
4.5. I often reflect on my problem-solving processes, how well they are working and make changes when necessary.	1	1	3	**8**	0
4. Problem Solving	**2**	**5**	**24**	**33**	**1**
5.1. I often strategize the time required to complete tasks.	1	2	***5***	4	1
5.2. I often complete tasks on time.	0	2	1	**10**	0
5.3. I feel comfortable working under time restrictions.	0	2	3	**8**	0
5. Time Management	**1**	**6**	**9**	**22**	**1**
6.1. I often contribute and participate actively in group work.	0	1	*1*	**7**	4
6.2. I often lead when working in a group.	0	1	*4*	**8**	0
6.3. I prefer others to lead a teamwork.	1	3	***6***	3	0
6.4. I consistently listen to, share with, and support the effort of others with respect	0	1	2	**7**	3
6.5. I can express my ideas confidently.	0	1	1	**8**	3
6.6. I often reflect on teamwork strategy and change accordingly.	0	1	5	**5**	2
6 Teamwork	1	8	19	**38**	12

Appendix 3: Thematic mapping from the reflection pieces