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'It was fun': Exploring the pedagogical value of collaborative educational games

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Introduction

The Europe 2020 strategy calls for the transformation of education and training to empower people ‘... through the acquisition of *new* skills to enable our current and future workforce to adapt to new conditions and potential career shifts ...’ (European Commission 2010, pp. 16-17 emphasis added). Redecker *et al.* (2011, p. 9), in a Joint Research Centre report for the EU Commission, categorises these new skills into three groups and argue these should be at the core of learning (and implicitly teaching): (1) personal skills (e.g. initiative, resilience, risk taking, responsibility, and creativity), (2) social skills (e.g. team working, networking, empathy, compassion and co-constructing), and (3) learning skills (e.g. managing, organising, metacognitive skills, and failing forward). Similarly, Suleman (2018), who reviewed employability skills studies to isolate and define ‘employability skills’, found some cognitive, technical and relational skills appeared across almost all studies; for example, communication skills, technical skills, teamwork, and cognitive skills, such as the ability to learn and analytical thinking. A Europe-wide survey by the Directorate-General for Communication (Eurobarometer 2010) found only 32% of employers were ‘very satisfied’ with graduates’ teamwork skills, suggesting this skill is deserving of particular attention. Previously, Redecker *et al.* (2011) challenged educators to ‘experiment with new formats and strategies for learning and teaching to be able to offer relevant, effective and high-quality learning experiences in the future’ (p. 10). Games have considerable potential in meeting this challenge (e.g. Qian & Clark 2016; Romero, Usart & Ott 2015), not least because games allow students to practise their employability skills in simulated ‘real’ work scenarios (e.g. Bowyer *et al.* 2008; Strachan 2016). Therefore, it is no surprise that serious games are used across diverse disciplines to support skill development, for example, business (e.g. Strachan 2016), medicine (e.g. Bowyer *et al.* 2008), and science (e.g. Cheng *et al.* 2015). The purpose of this article, therefore, is to investigate the use of games as pedagogical tools to enhance the learning process for working in teams, and to suggest a learning activity that can create a positive collaborative learning experience in higher education settings.

Games and collaborative learning

Games are identified as a key tool in the academic arsenal that can develop 21st century skills for today’s graduates (Prensky 2006; Redecker *et al.* 2011). Moncada and Moncada (2014, p. 18) explain that games ‘... offer instructors a viable, stealthy, teaching and learning strategy that capitalises on *collaborative play* to engage students’ (emphasis added). The goal of collaborative game-based learning (GBL) is to enhance collaborative learning (Romero *et al.* 2012). Collaborative learning involves small groups of students working together to achieve a shared learning goal. Characteristic of successful collaborative learning is shared knowledge building, the outcome of the combination of individual group members’ ideas, perspectives, and talents. Accordingly, how group members interact and work together influences the outcome.

Johnson and Johnson (1999) delineate five ‘basic elements’ for successful cooperation: (1) *positive interdependence*: success is group dependent and group members must cooperate to succeed in achieving the learning goals; (2) *individual accountability*: group members are held accountable for sharing and contributing equally to the work; (3) *face-to-face promotive interaction*: group members purposefully help each other to learn by providing feedback, challenging conclusions, teaching and encouraging each other; (4) *social skills*: group members use and actively work to develop appropriate interpersonal and small groups skills such as, trust-building, communication, conflict management and decision making skills; and (5) *group processes*: group members regularly evaluate how well the group is doing in attaining their goals and in maintaining effective working relationships (Johnson & Johnson 1999). Collaborative GBL emulate these ‘five pillars’ when

designing collaborative games (e.g. Hsaio et al. 2014). Hsaio et al. (2014), Romero et al. (2012) and Hämäläinen (2011), among others, demonstrate that multi-player computer-based GBL has real potential for enhancing collaborative learning through shaping how learners interact with one another, that is, when interaction is characterised by positive interdependence and shared knowledge construction.

Meta-analyses are unanimous in their conclusion that GBL has a positive impact on learning, especially with regard to cognitive outcomes (e.g. Boyle *et al.* 2014; Clark, Tanner-Smith & Killingsworth 2016; Lamb *et al.* 2018; Qian & Clark 2016; Vlachopoulos & Makri 2017; Vogel *et al.* 2006; Wouters *et al.* 2013; Wouters & van Oostendorp 2017; Zhonggen 2019). However, few studies have considered the behavioural learning outcomes of GBL, such as collaboration, teamwork, and social skills (Qian & Clark 2016; Vlachopoulos & Makri 2017). Vlachopoulos and Makri (2017) report mixed results in this area with some studies showing GBL provides opportunities for collaborative learning, interactivity, and feedback among players, while others contradict these findings. It is important to note in the context of this study that the meta-analyses reported above focus on digital or computerised games only, so it is not known if the findings would differ if simple low-tech games were the focus. In addition, Wouters & van Oostendorp (2017) and Zhonggen (2019) point out that effectiveness of learning can be improved by a greater focus on different pedagogies and instructional strategies. This represents a shift in focus from *whether* learning occurs to *how* learning occurs, suggesting a focus on the rationale for use, the teaching and learning strategies employed, and whether the outcome is warranted.

Several factors should be considered when selecting and implementing a game as a learning tool. A significant moderator is whether games are used as the only instructional method or are supplemented with other instructional methods. Vlachopoulos and Makri (2017) and Boyle *et al.* (2014) indicate that games work best when integrated into well-developed and coherent curricula. More specifically, Wouters *et al.* (2013) conclude that students learn most when the game is supplemented with other instruction methods, involves multiple sessions, and when players work in groups. Building in opportunities for formal debriefing or to actively reflect on the experience is also thought to benefit learning (Garris *et al.* 2002; Wouters *et al.* 2013). This is possibly even more important when the focus is on collaborative and team working skills.

The design of the game is another determining factor in its effectiveness for learning. To be effective games should have certain qualities: task involvement, immediate feedback, interaction, active participation by the student, player control of their learning, repeated practice, challenge, motivation, enjoyment, dialogue between players, and teamwork (Sauvé *et al.* 2007; Whitton 2014). Sauvé *et al.* (2007) add that games which employ a socio-constructivist pedagogy are more suited to meeting the learning needs of the current generation of students, characterised by multitasking while learning, short attention span during learning, and an exploratory and discovery approach to learning. Collaborative learning opportunities are 'built-into' the overall experience of some games, for example, when games are interactive, reward problem solving and collaboration, promote 'out of the box' thinking, encourage individual accountability, give instant feedback, and when the goal is to win as a team (El-Nasr *et al.* 2010; Garris, Ahlers & Driskell 2002; Sharp, 2012).

The nature of the task (collaborative rather than competitive) determines the quality and nature of group interaction and by extension the learning outcomes (Johnson & Johnson 1999, Zagal, Rick & Hsi 2006). Tomcho & Foels (2012) suggest that tasks requiring high levels of participant interdependence result in greater learning. Furthermore, Verzat, Byren & Fayolle (2009) remind us that it is important to use fun activities in class as a means of fostering active learning, not least because a correlation has been found between student self-reported enjoyment and improvement in deep learning and higher order thinking (Crocco *et al.* 2016). As a corollary, collaborative games

facilitate collaborative learning when students work together to help one another learn (Romero *et al.* 2012; Murray 1994). By working in teams, particularly when working together consistently over time, students gain a sense of relatedness to one another's learning styles and techniques (Sweet & Michaelsen 2012). This facilitates greater peer collaboration and peer learning and creates what Vygotsky (1978) termed a 'zone of proximal development'; a fertile learning area between what one student knows and what they can learn from others.

Choosing (or developing) the 'right' game is a further consideration, with some better suited than others to developing certain skills. Romero *et al.* (2015) indicate that collaborative games develop skills such as communication, cultural awareness and decision-making, while strategy games help develop planning, flexibility and adaptability skills. They conclude that complex collaboration (i.e. requiring a high degree of collaboration) is the game characteristic that contributes most to the development of 21st century skills. Essentially and particularly in the case of teamwork, '... doing it rather than listening about how important it is, is likely to have a more direct impact on student understanding' (Verzat *et al.* 2009, p. 209). Designing computer-supported collaborative games has been identified as 'extraordinarily difficult' (Zagal *et al.* 2006, p. 27) and while there is promising research in this field, it is still emergent (e.g. Hämäläinen *et al.* 2018; Oksanen 2013). Consequently, tried and tested low-tech games may have more to offer in supporting collaborative learning currently.

Clearly, games have merit in simulating team-work experience(s) for students, and as has been seen, there is some evidence that under certain circumstances games can facilitate collaborative learning. Only one study (Verzat *et al.* 2009) was found that investigated specifically whether simple low-tech games help students to learn about teamwork. In this study, the spaghetti game, which involves teams building structures capable of bearing weight using spaghetti and thread, was used as an initial ice-breaker and was part of a broader creativity and teamwork programme, was used with 666 engineering students (or 111 groups of six people) over a three-year period. Data collected in the form of students' written feedback and eleven semi-structured interviews revealed concrete learning about team processes among participants. This study is rare in that it evaluates the use of a low-tech as opposed to computer-supported game-based learning.

It is argued that simple low-tech games are important and have potential for learning that is undervalued, not least because they are face-to-face and inherently social and interactive. Furthermore, relatively little attention is paid to student experience and voice in the research in this field. Consequently, this study explored (1) students' perceptions of, and response to, a simple, low-tech, classroom-based educational game; (2) whether participating in a team-based educational game resulted in student learning about how to work effectively in a team (i.e. thus supporting collaborative learning); and (3) whether and how they planned to apply this learning when working collaboratively.

Methods

This study employed a qualitative descriptive design. Qualitative description (QD) is naturalistic (Sandelowski 2000, 2010) and aims to provide a 'comprehensive summary' of participants' experience in their own voice (Sandelowski 2000, p. 336). This 'summary' is a 'straight' (minimally theorised) description of the facts and the meanings participants attach to those facts (Sandelowski 2000, p. 336). The end-product of QD, therefore, is a vivid detailed account of study participants' perceptions of an experience/event/process using their words. This choice of methodology is suited to the exploratory nature of the research questions and appropriately (in context of the research questions) keeps students' 'voices' to the fore.

Data Collection

An open-ended questionnaire was used to collect the data. The questionnaire was designed specifically for this study and comprised of six open ended questions. Similar to the approach adopted by Verzat *et al.* (2009) question construction was guided by the Kirkpatrick Four Level Evaluation Model (Kirkpatrick & Kirkpatrick 1959, 1994). The questionnaire addressed the first three levels of Kirkpatrick’s model (see **Table 1**). It was not possible to address Level 4 (results) as the game was used at the beginning, as opposed to the end, of the teamwork experience. To allow students scope to comment further a final open question was included – ‘Any other comments or recommendations?’

Table 1: Questionnaire questions

Levels		Questions
Level 1	Student reaction	What did you think of the game? Describe the approach the group took to achieve the set task. Describe how the group interacted.
Level 2	Learning outcome(s)	What did you learn from participating in the game?
Level 3	Behaviour and/or attitudinal change	How will what you learnt influence how you will work/behave in future group work?

Sample

A convenient sample of nine classes of first-year undergraduate students (n = 181) taking a critical skills module were invited to participate in the study. A module aim is that students will ‘understand the characteristics required for a successful team-based project.’ This learning is facilitated through students working in a team to collaboratively write a White Paper and develop a poster. These assignments involve considerable time and effort and the teams remain together for the bulk of the module (8 out of 12 weeks). A team-based educational game was introduced as an experiential learning activity to help students learn in a practical way the characteristics of effective team working. Each class was divided into teams of four to five students. At the end of the game, students were invited to complete the questionnaire. Their participation in the study was voluntary and anonymous. Ethical permission was obtained from the University Ethics Committee. In total 140 (RR 77%) students completed the questionnaire.

Team Assignment

Students were allocated to teams using CATME Team-Maker ©, a web-based programme, which supports criterion-based team assignment. We were conscious that group allocation has a significant impact on group functioning, so careful consideration was given to the criteria. The criteria finally selected were academic performance, gender, schedule, commitment level and preferred role in group (chosen around the broad themes of leader, follower, big picture and detail). Before embarking on the first group work assignment, students were asked to complete a CATME Team-Maker survey online. In this survey students first self-reported: (1) their gender (male, female, prefer not to say); (2) their grade from the previous semester; and (3) their writing ability (basic, average, good, excellent). Secondly, they indicated: (1) the hours in their schedule they were free each week; (2) how much time (in hours) they were willing to spend on groupwork outside of class; (3) what their preferred role in a group was (choice of leader, balanced, follower); and (4) their preference in terms of group roles (i.e. single leader, one leader with input from others and finally, shared leadership). Upon completion of this survey, CATME then suggested groups of three or four students. The functionality of CATME Team-Maker gives the instructor final say on the composition of the groups and allows them to change students’ group assignment. Student allocation was changed in

accordance with inclusive practice principles where warranted, for example, when a female was allocated to an otherwise all male group, or vice versa to avoid issues surrounding voice domination and participant exclusion (Lockheed *et al.* 1983). One value to CATME is that when groups are established and introduced to one another, it allows students to see one another's availability (i.e. shared gaps in their timetable), thereby facilitating potential meetings outside of class.

The resulting groups are best described as homogenous-ability groups. Homogeneous groups are more cohesive and are more likely to increase participation by all group members (Rezaei 2017). For example, Wichmann *et al.* (2016) found that less active students are more productive in homogeneous groups, suggesting that grouping less active students increases their participation because social loafing is more difficult. On the other hand, high-ability students seem to be more productive in heterogeneous groups (Wichmann *et al.* 2016), although in some cases such groups experience more challenges in a different and more intense way (Dweck 1986; Monteil & Huguet 1993; Soetanto & MacDonald 2017). Given a persuasive argument can be made for using either homogeneous or heterogeneous groups, the final choice must be shaped by the purpose or goal of the group work. Rezaei (2017, p. 17) concludes that 'if the goal is for all students to reach a specific level of learning or to reach a specific level of achievement, then perhaps heterogeneous grouping is the best option, however, if the goal is to have students maximize their capacity as learners, homogenous grouping may work better'. We had two main goals: (1) that students would produce work that both developed their skills and maximised their potential; and (2) that they had a positive team working experience. Homogeneous groupings offered the best approach for us in meeting these goals.

The Game

A team-based problem-solving puzzle was used (see Hedges & Pedigo 2002 for a full description). This game was selected because of its focus on providing students with an opportunity to understand the characteristics of effective teams (Hedges & Pedigo 2002), its simplicity (all that is required is printed copies of the instructions) and that it is possible to run in a one-hour time slot. Moreover, the game complies with the qualities for supporting collaborative learning outlined above, for example, it is interactive, promotes dialogue, interdependence and teamwork, provides immediate feedback, and is challenging. The puzzle is built around five farmers, their names, houses, location, vehicles, animals and what they grow. These 30 pieces of information are written as statements, for example, 'The dogs' owner lives next door to the house with a plum orchard'. The statements are divided equally across team members, consequently each team member has a unique set of 'clues'. The objective of the puzzle is to identify who drives a truck and who grows apples. A critical element of the game is that the facilitator does not define for students what they need to do, instead the task and the questions are buried among the other 'clues'. There are two rules, students are not allowed to write anything down, nor can they show each other their set of 'clues'. To solve the puzzle students must communicate well, listen carefully and devise a strategy to collate the sometimes overwhelming amount of information. Students are allocated 30-40 minutes to solve the puzzle.

Based on their observation, Hedges and Pedigo (2002) report that the game enhances students' understanding of the characteristics of effective teams, demonstrates practically the differences between nominal and functional teams, provides a way to measure their own group processes, and acts as a motivator to develop the teams to which they belong. They indicate the game can also be used to practically illustrate communication skills, interpersonal interactions, organisational commitment, and organisational capital. However, student perspectives and experiences of the game or what they identify as their learning was not explored. Hedges and Pedigo (2002) leave it to the

judgement of the facilitator when best to run the game but recommend that participants should at least know one another sufficiently for mutual respect and trust to begun to emerge. This leaves many questions, for example, is the game more or less effective when the group is beginning to form? Or is learning more or less meaningful if team members will actually work together on a project? They also recommend that the game should be run with groups in separate locations to prevent competition and the possibility of groups sharing information. This would not be feasible in most situations, and in this study multiple groups worked to solve the puzzle in the same room.

Students had already been divided into teams and they were aware that they would work in these teams on the two assigned projects for the remainder of the module. The game was run on the first day of introducing the team-based element of the module. Participants had been in their class for a precursor module so knew one another but not necessarily very well. They were not given any instruction on teamwork or the characteristics of effective teams prior to the game. The researchers acted as the facilitator of the game for each of their classes. The groups were allocated a set of instructions and each member was allocated a page of 'clues'. The facilitator simply informed the class that the group had a problem to solve and that 'the actual task, and how you are to go about it, will become clear once you start to share information with the other members of the group.' The facilitator did not intervene further except to confirm if the group had solved the puzzle and to call time.

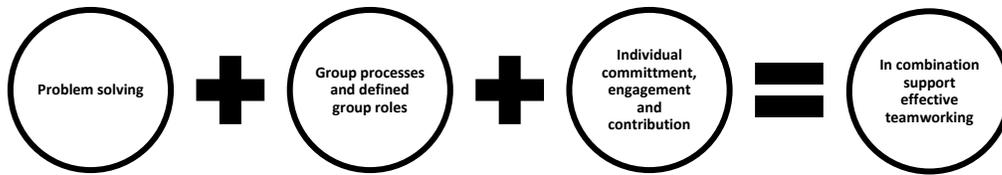
Data Analysis and Trustworthiness

Conventional qualitative content analysis was used to analyse the data (Hsieh & Shannon 2005). A characteristic of conventional qualitative content analysis is that codes are derived directly from the data themselves (Hsieh & Shannon 2005). Data were initially coded using exact words from the text to label key thoughts or concepts. These codes were sorted into categories based on how the codes related and interlinked. Emergent categories were further collapsed into 'meaningful clusters' (Hsieh & Shannon 2005, p.1279) which summarised the data well. This iterative process continued until a small number of categories emerged which held true for the data (Sandelowski 2000).

Both researchers (AC and ED) independently coded the data. One researcher (AC) took overall responsibility for categorising the data and writing up the findings. The other (ED) tracked the whole analysis process and categorisation to check (1) the adequacy of the analysis and (2) the representativeness of the data as a whole (Elo *et al.* 2014). Any divergence of opinion was discussed critically until agreement was reached, with very few modifications required. Extensive quotations are included in the write-up of the findings to allow readers to judge for themselves the trustworthiness and adequacy of the analysis (Elo *et al.* 2014).

Findings

It was found that participating in the game did enhance students' (1) understanding of what it takes to work effectively in a team, and (2) increased their awareness of the factors required for a high performance work team. Three categories were found that describe students learning about effective teamwork: 'problem solving', 'group roles and group processes' and 'individual commitment, engagement and contribution'. The relationship between these categories is depicted in Figure 1.

Figure 1: What students learnt from the game

Students were overwhelmingly positive about the game, describing it as ‘fun’ but added that it was also ‘frustrating’. Some gave vivid descriptions of their frustration: ‘head melting’ (G05), ‘head wrecking’ (M14) or ‘brain frying’ (Q17) but clarified this was ‘... in a good way’ (Q17). This student explains this dichotomy clearly: ‘It was a challenging activity. It was fun but frustrating at times. It was rewarding to finally get it right.’ (U09). Students indicated that the game also ‘broke the ice’ and helped the team to ‘bond’ and ‘get to know one another’. However, they also recognised that the purpose of the game transcended this. Data analysis revealed that the game helped students to learn (through their experience) about the many requirements for ‘good’ teamwork. This is explored under each category.

Problem solving

Students used a variety of approaches to solve the puzzle. These break down into two main categories: (1) an ad hoc approach, and (2) a planned strategy to solve the puzzle. Employing an ad hoc approach involved students using ‘trial and error’ (D04) and ‘guessing’ (G04) to try and solve the puzzle. This approach had the beauty of simplicity but was not always successful, causing students to conclude that it was essential to make a plan when working in a team.

(Our approach) haphazard sharing of information. Ruling out. Guessing. (G04)

(I learnt it is important to) plan before you jump into the task. We were excited about the game so straight away started spouting out information on our sheets that was irrelevant to the task and kind of made it more confusing. (N04)

In contrast, some groups formulated a plan to solve the puzzle. Their plan evolved as they worked together but typically centred on coming up with a strategy to help them remember what they already knew. Some groups were very creative in finding ways to remember the information.

We used objects to create a ‘map’. Each piece of information was represented by an object. (F17)

We used our bodies to mimic the neighbours in an effort to visualise the row of houses. (Z11)

Irrespective of approach, the game afforded participants learning opportunities beyond the stated purpose of the game. Students made clear that they planned to apply this learning when engaging in team projects.

I now know to share relevant information with my group instead of giving all the information. (M08).

I learned that teamwork is essential with limited knowledge on one aspect of a story. More than one point of view is necessary. (Q17)

Group roles and processes

Students recognised that team performance was dependent on how well individual team members communicated and interacted (*Group processes*). Solving the puzzle required each team member to communicate what they knew (their clues) and to listen carefully to identify links (between clues). It is no surprise (given the purpose of the game) students indicated that the game had taught them that communicating well is critical to both team effectiveness and positive team relations.

... we need information which the other members bring to the group to complete the task. I've learnt it is critical to interact with your team and good communication is key. (G15)

Clear verbal communication is vital in group work. Working together as a team and brainstorming helps solve problems. (M13)

Typically students took turns talking and listening to one another – ‘*We spoke. We listened.*’ (G05). They described their interaction as ‘*respectful*’ (M04), opinions and suggestions were ‘*valued*’ (F13), and ‘*all suggestions were considered*’ (D06). While most students felt other team members listened to them, this was not the experience of all students.

One person dictated everything from the start ... (when identifying what s/he learnt this student indicated that it is important) ... not to have one person controlling everything, everyone should have equal roles. (F10)

(Group interaction was) pretty good but it was obvious a leader had taken charge. (D12)

Across groups there was some evidence of a conflict between competition and cooperation. Some students were so focused on solving the puzzle that they delegated memorising information to other team members while they pushed on to find the solution. Students resented the unequal division of the task of remembering. This flagged for students the importance of having a clear team structure and fair distribution of work.

... we were weak at taking charge of individual information; everyone was looking for somebody to remember everything while they solved the rest of the riddle. This student later highlighted that it was important to ... choose a definite leader to coordinate tasks of the group. (G04)

(I learnt that) a structure and a team leader help to keep order during a group task. (M14)

Interestingly trying to solve the puzzle gave students an opportunity to evaluate their team mates abilities. Some concluded that a group member(s) was unlikely to pull their weight. More positively, others recognised their peers’ strengths’ and valued the opportunity to learn from them. Irrespective of outcome, it is worth noting that students formed judgements on their colleagues on the basis of approximately 40 minutes interaction.

Personally I figured out who would put more effort into the group work and who are the better communicators of information. (M19)

(The game) helped me trust my team’s ability to equally participate. We were about to give up with 3 minutes to go but stayed with it and got it (right). (G17)

Students reported that even at this early stage leaders were emerging (*group roles*). One student thought this an important outcome of the game ‘*Very good to decide who is the leader and follower of a group.*’ (M11). Others took the opportunity to evaluate their own roles in the group.

You could see the leaders and followers clearly. I learnt I am more of a follower definitely. (G09)

(I learnt) that I like to take charge. (F12)

The game afforded some students insight into how they behaved in a group. Perhaps more reflective than others, these students learnt something new about themselves.

I learned that I tend to take charge ... I will be conscious of the fact that I speak out a lot. I will try to ask for everyone's opinion and not talk over people. (F14)

Helped me notice when I wasn't communicating the best. (N05)

Individual commitment, engagement, and contribution

Students highlighted that to succeed '... everyone's contribution is needed' (G13). They commented on the value of having access to differing viewpoints and ideas across the group. Others noted that if members of the team 'opted out' of the game it impacted negatively on overall team performance. Students concluded that it is critical that everyone commit to the team and actively engage in its work. They also recognised that this needed to be facilitated by the members themselves

I learned that group work is very much dependent on mutual effort and cooperation from each group member. (Q03)

I think the game was effective in teaching team work. It got quite frustrating at times which for some players made them lose focus and impacted negatively on the whole team. (N04)

Equally students recognised that being passive hindered effective team functioning. They noted the importance of speaking up, that sharing ideas and opinions is critical to team success. The message for students therefore was to be more confident and to voice their opinion.

... each person have to play their part. (I will make) sure that I play my part of the group so we can reach the best potential. (F06)

I will be more confident and be more inclined to get involved and voice my opinion. (F04)

Overall learning

Students made clear that they anticipated *applying* what they learnt when working collaboratively on the group assignments. Students indicated that it is important to: actively engage in and contribute to the group's work, communicate their ideas clearly, negotiate and actively listen to all team members, formalise roles and make a plan, focus on evaluating and interpreting data carefully and to think laterally. The game also helped students to feel more positive about group work.

(I learnt) that team work can be fun (G14)

It ... persuaded me to engage very heavily in group work. Great craic! (Q05)

Finally, students made clear that they enjoyed learning in a less structured and fun way.

This is great for allowing the group to see the problems with initial group interactions (Q09).

It's a good exercise to get the whole team communicating and working together. (Q12)

I really enjoyed this game and would love to do more of them in the future. Highly recommend it for other classes. (F04)

Discussion

This article aimed to understand three aspects of the use of serious gaming to enhance in-class group work. First, we wanted to know what students' perceptions of educational games were. Secondly, did this game teach students to work more effectively in teams? Finally, would students apply their learning from this experience to future group work projects? These are important questions because learning to work effectively in teams is important for students' future employability.

In the first instance, students were largely positive about the use of serious games as an educational resource and the findings indicate that students did learn from participating in the game. The game was simple and fun, helped to break social barriers, and encouraged greater participation in the group activity. Several students gained confidence, for example, they were more willing to share what information they had because they understood this was necessary if their group was to succeed in the task. In this way, the game facilitated a zone of proximal development by catering for students' low-level needs. The game created a relaxed environment where students were comfortable sharing information to acquire new knowledge (Vygotsky 1978). It is also encouraging to note that most students saw the value in groups working together to solve a complex task.

Secondly, building on from the tentative findings of Hedge and Pedigo (2002), by participating in the game students saw first-hand from a very practical perspective how groups operated. They appreciated the value of communication, the necessity of designated team roles, and the importance of their own individual contribution (and others') for the successful completion of the task at hand. Some recognised their preferred role in groups, although only in terms of a Manichean dichotomy of either a follower or a leader. Thus, students gained a valuable introduction to the importance of individual accountability and positive interdependence (Johnson & Johnson 1999). Due to the very nature of the game, which required face-to-face communication, students were predominantly pre-occupied with communication in their responses. Interestingly a small, but significant, minority spoke of appreciating the importance of listening to others and saw it as a significant factor in group dynamics. Both of these findings provide further evidence about the relationship between student self-reported enjoyment and improvement in higher order thinking as outlined by Crocco *et al.* (2016).

Finally, having completed the game and the questionnaire that we circulated student participants took the opportunity to reflect on what they had learned and to identify where this knowledge may become useful in the future. Some participants noted that they needed to speak up more while others realised that they needed to take a leadership role where there were none in their group. Students were therefore prompted by the game to reflect on their own performance and the learning styles and strategies of their peers in order to establish a solid foundation for their group work projects. This supports Wouters *et al.* (2013) conclusion that building in opportunities to reflect on the experience benefits learning (Wouters *et al.* 2013). The game illustrated for students the five pillars for successful teams and teamworking (Johnson & Johnson 1999) in a practical way, that is, positive interdependence, individual accountability, face-to-face interaction, social skills and maintaining a focus on group processes. These pillars resonate with what students identified as their key learning. We argue that experientially learning about what makes a team successful has far more meaning for students than a theoretical session on the characteristics of successful teamworking. To return to an earlier issue we raised about the timing of the game, where Hedges and Pedigo (2002) did not

indicate a clear preference, we recommend that this activity be used as an introductory activity for the groups after their formation.

There were also a small number of unintended consequences to the use of the game. First, a significant number of student participants noted that their analytical skills were enhanced as a result of their experiences. Without continuous guidance from instructors, students had to identify not just the task at hand but also what was *relevant* information that needed to be shared with others. This encouraged them to prioritise information and evaluate what was important to succeed. Secondly, through observation instructors were able to identify groups that did not function as well. Many student participants were concerned about social loafing within groups and/or the negative impact of over-bearing group members and during the game some individual students were observed to opt out of the game as a result. Shepperd (1993) explains that low group productivity results from lost motivation arising from individual members' perceptions that: (1) contributing is of no personal benefit because the outcome/product is unimportant, their efforts are unseen, or unrewarded; (2) their contribution is unnecessary or dispensable so they coast (free-ride); or (3) the cost of contributing is excessive or outweigh the benefits. These categories are useful in conceptualising the factors that might be at play when group dynamics and processes are poor. Thus, this game could be used as a useful exercise to introduce the concept of conflict management, and to begin discussions on the importance of good communicative practices and individual participation and engagement.

Facilitators could also at this stage change the membership of some teams. This cannot simply be measured by whether groups solve the puzzle (although it can be a useful indicator), rather facilitators can observe communication patterns between group members and act accordingly. Oakley *et al.* (2004) outline a useful teaching strategy to support students' learning to manage conflict that involves first reading a short but detailed piece about social loafing in groups and then writing a reflective essay on the significance of the piece to their own perceptions of their role and performance in a group. Their thoughts are then used as a basis for a team contract where groups outline what is expected of each member and the procedures they will employ to deal with problematic members. Thus, this game can provide a very solid platform to build upon in the classroom for further learning on how to manage team processes and interaction.

Limitations

This study has a number of limitations and further research in this field is recommended. Firstly, the data is representative of a single and short learning experience. It is not known if students did apply (as opposed to thinking they would apply) their learning when working in a team. Nevertheless, the game did make students more conscious of what is involved in working effectively in a team and as a team. We argue that this awareness is more meaningful for students because it emerged out of their own experience (facilitated by the game) and their 'reflections' (in the loosest sense of the word) prompted by the activity of completing the questionnaire (which was an unintended but happy consequence) as opposed to theoretically reading or hearing about high-functioning teamwork. Secondly, it could be argued that students' experience and learning may have been shaped by the characteristics of the group and not solely the outcome of the game. However, the large sample size (large in context of a qualitative study) should off-set this to a large degree. Furthermore, it is suggested that students knowing that this is the group they will be working with (as opposed to a randomly formed group) would make the experience highly significant for them, for example, their perceptions on how effectively the group collaborated. Building on students' experience (as suggested above) in further sessions is important therefore, if the learning experience is to be capitalised on fully.

Conclusion

To conclude, this serious game is a viable learning (and teaching) strategy that effectively uses collaborative play to support student learning. Most students became more confident in their ability to participate in teamwork and began to recognise the importance of their contribution and intra-group collaboration for the successful completion of the task. The game prompted participants to reflect on the factors that underpin successful teamwork and provided them with useful practical experience that students believed could be applied to their future learning. Inevitably some students learnt less from the experience than others. They engaged with the game but failed to see its wider relevance to learning about team working. Nevertheless, this study findings suggests that serious games are useful pedagogical tools (and are recognised as such by the majority of students) that foster collaborative learning in a stealthy, fun way. Classroom-based and low-tech games have a lot to offer in generating high quality collaborative learning experiences. We suggest they should not be forgotten in the rush to develop computer-supported collaborative learning environments.

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