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Abstract

Gamification is used encourage the learner to participate in a competitive activity, to encourage engagement and desire to learn. In the Radiographic Practice module, students learn three core radiography performance standards; professionalism, technique and clinical performance. To address these standards, a pilot radiography board game was developed to determine its effectiveness at improving engagement and interest with learning material and its use as a teaching and learning tool. A qualitative, explorative descriptive research design was used, involving focus group interviews with the radiography students. The students recommended some changes and adjustments on the game design and dynamics. They further described the board game as a fun activity and demonstrated that it was possible to learn whilst engaging with the subject material and group discussions. The board game enabled the students to apply critical thinking skills and be introduced the concept of professionalism in the clinical setting.

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1. Introduction

Gamification is defined as an application of game design principles in non-gaming contexts, like in business or in education (Robson, Plangger, Kietzmann, McCarthy, & Pitt, 2015). In the context of education, gamification is seen as an instructional method requiring the learner to participate in a competitive activity that has predetermined rules (Gentry et al, 2016). Research on educational gamification regard it as a way of motivating or getting the students to engage and be more excited about the learning activity at hand. In Schell's words (Schell & Schell, 2008), games create experiences and experiences change people. (Hanus & Fox, 2015), acknowledge that gamification in education, does contribute to transformation in the way students learn, because it has a potential to increase motivation, engagement and enjoyment of the task. These authors go on to highlight the positive side of using gamification as the ability to provide immediate and frequent feedback on the activity at hand. With regards to negative impact, these authors raise concern over the increased social comparison, competition and rewards systems. In the views of Buckley and Doyle (Buckley & Doyle, 2017), it is important to know that individual characteristics impact on the efficacy of gamification. These authors go on to caution that it is important that gamification be used to suit the desired pedagogical interventions. In line with the need to train more healthcare professionals. Gamification is one method that can be considered as being innovative in educational programs that will also contribute to

improved patient care (Gentry et al, 2016). This is seen as transformative and satisfying as compared to the traditional classroom teaching and assessments, where feedback is usually given after some time. Schell (2008) describes the importance of information flow from player to game and back to player as feedback that has a potential to influence how much the player understands and enjoys the game. It is based on studies like these that lecturers in the Department of Radiography decided to design a board game for implementation in the radiographic technique module. The objective of designing this board game was to determine if it will have a positive contribution to enhance teaching and learning in both the theoretical and practical part of this module.

The games used in the teaching and learning environment are designed and played according to the principles of leisure games, whose focus is on the use of skills, strategy and luck (Margarida, Mireia, & Michela, 2015) The goal of these games in a higher education environment, is essentially to sustain engagement with the study material, create a platform for discussion, as well as enhance quick thinking and decision making skills (Becker & Watts, 2001). Gaming is regarded as a simulated learning in healthcare education and has proven to serve different objectives and specialities (Wang, DeMaria, Goldberg, & Katz, 2016). Simulated discussion and reflection provide an excellent way of teaching and problem solving Bensinger (Bensinger, 2015), and Hanus (Hanus & Fox, 2015), describe the advantages of gamification as provision of immediate and frequent feedback in the teaching and learning environment. Robson et al., (2015) say gamification can change behaviour because it taps into the motional drivers of human behaviour through reinforcement and emotions. As reported by Aburahma and Mohamed (Aburahma & Mohamed, 2015), the games were introduced in the pharmacy curriculum to re-inforce the integration of the course material by creating an interactive, enjoyable and motivating learning environment for the students.

The lecturers in the Department of Radiography, who are also researchers and authors of this article, wanted to determine if the principle of leisure games can help in motivating and enhancing students' engagement with the theoretical and practical components of the radiographic technique module. These lecturers developed a board game based on the principles of snakes and ladder as well as the monopoly games. As part of the pilot project, first, second and third year Radiography students were invited to participate. The students who volunteered to participate, were first given the opportunity to engage with the game before participating in the focus group interviews. Before presenting an overview of how the Radiography Board Game was designed and piloted, some background is necessary on how teaching and learning in the Radiography technique module is structured and undertaken at this university.

1.1 Teaching and learning in the radiographic technique module

Radiography is a core module which runs from the first to the third year of study. It is important that the students are able to articulate what they learnt in the first year into the second and the third year of study. In this module, teaching and learning is structured to address all three radiography performance standards as defined by the American Society of Radiologic Technologists (ASRT). These standards are for

professional, technical and clinical performance (Ehrlich and Coakes, 2013). To address all three performance standards, teaching and learning takes place in both the practical and clinical environments. Work integrated learning is the term that is given to the situation where the students take what they learnt in class and put in into practice in the clinical environment. According to the Higher Education Qualifications Sub-Frameworks (Counsel on Higher Education, 2013) in South Africa, work integrated learning can take either of the following five forms; simulated learning, work-directed theoretical learning, problem-based learning, project-based learning as well as workplace-based learning. Work integrated learning is based on the principles of experiential learning. Kolb (2015) describe experiential learning as a theoretical perspective on the individual learning process that applies to all situations and arenas of life. Whichever form of teaching and learning the lecturer might choose, it is important as stated by Brown, Roediger & McDaniel (2014), that the method does not only teach, but strive to assist the students to learn better.

The lecturers have over a period of time, attempted different methods to encourage active engagement with the module contents with the view of helping the students to gain competency in the three performance standards as defined by the ASRT, namely; professional, technical and clinical. This can be related to what Engel-Hills (2005) describes as a need to review how education in Radiography takes place and move away from the expectation that knowledge will diffuse from staff in the work environment to the students. In an attempt to do what Engel-Hills recommended, the lecturers identified a number of teaching and learning methods. One such method was the introduction of the image critique form. This form was included in the students' log-books. Students were encouraged to take time, when in the work integrated learning environment, to retrieve radiographic images from the computers in the x-ray rooms and start the critique. A minimum number of images that each student is supposed to evaluate is stipulated and this varied from the first to the second and third years. Encouraging self-learning is in line with the principles of WIL. Frances, Hills, MacDonald-Wicks, Johnston, James and Surjan et al., (2016) describe work integrated learning as a process that assists students to achieve or acquire skills, knowledge and attitudes required meeting the minimum requirements as set by the university or registration authorities. The lecturers later realised that the students only completed these forms when the log-books are due to be collected. This delayed feedback to students also meant that monitoring of whether they were carrying out the task was not immediate. This can be associated with what Grey et al (Grey, Grey, Gordon, & Purdy, 2017) report about studies where students were cheating the system, by recording their attendance at the learning sessions, while they were no necessarily engaging with the learning activities.

According to de Freitas, Gibson, Du Plessis et al (2016), there is a need to have a clear alignment between the objectives, facilitation methods and assessment of activities in the work-integrated learning. The statement relate very well to Biggs' (2003) theory of constructive alignment. In critiquing Biggs' theory of constructive alignment, Larkin and Richardson (Larkin & Richardson, 2013) highlight that it depends more on what the student does in determining what is learnt, than what the teacher does. Other critiques of Biggs' theory of constructive alignment, whose contribution seem to shed some light on how radiography students

engaged with the image critique form and simulated assessment are Trigwell and Prosser (2014). These authors argue that Biggs' theory seem to assume that students will engage in appropriate learning activities that is, students are intrinsically motivated. As the lecturers who are involved in the radiographic technique module noted, this assumption proved to be incorrect as the students only prepared self and the image critique forms for the submission dates.

1.2 Research aim of the study

The research the aim of the pilot study was to explore how the radiography students experienced the radiography board with regards to teaching and learning in the radiography technique module. The next section outlines the activities undertaken in designing and piloting the radiography board game.

1.3 Designing the radiography board game

The design stage is the important aspect of the development of the game. According to Schell (2008), for one to design a game, one must take time to listen to the team, audience, game itself, client and self. This can be translated into saying that, designing a game, especially if it is for educational purposes, needs thorough planning and preparation. The lessons learnt prior to designing the radiography board game are outlined.

Game design is said to encompass three main principles, namely; game mechanics, dynamics and aesthetics (Grey et al., 2017; Kim, 2015; Robson et al., 2015). This is the MDA (mechanics, dynamics and aesthetics) framework that was coined by Hunicke, LeBlanc and Zubek (2004). These authors further describe the three principles as follows; a) mechanics is the overall support for the game play, b) dynamics works to create an aesthetic experience and c) aesthetics is what makes the game funny. Robson et al.(Robson et al., 2015), and Robson et al (Robson et al, 2016) also describe the three gamification principles according to the MDE framework. MDE stands for mechanics, dynamic and emotions. From the article by Robson et al (Robson et al: 2016), the relationship between the two frameworks can be expressed as 'aesthetics evoke emotions' in the player. It is therefore important, as Bohyun (2015) and Robson et al (Robson et al, 2016) put it, that, the perspectives of both the designer and the player be taken into consideration as one develops a game for learning purposes. Browning (2016) takes this argument further by stating that, in designing games for learning purposes, one should consider both the intrinsic motivation and effective engagement of the player or student, by focusing on the interplay between the outcomes and other vectors of the design. This author, then introduces, the mechanisms, dynamics, aesthetics and outcomes (MDAO) framework. Grey et al., (2015) emphasise the need to ensure that learning actually takes place during gamification, by highlighting the need to take the learning outcomes into consideration during the game design phase.

In addition to these lessons that the lecturers had to engage in prior to designing the radiography board game, there was the need to involve the graphic designers. This is supported by Kickmeier-Rust & Albert, (2012) who describe three main approaches for designing games for learning purposes as; a) the students themselves design the game and the questions, thereby learning the content as they build the game; b) integrating commercial aspect of the shelf games into the classroom and adapting them to suit the learning need and finally; c) the educator and graphic designer build an education game from scratch based on the

learning outcomes of the module. In designing the radiography board game, the lecturers adopted the second and third approaches, together with the clarification of the expected learning outcomes. The snakes and ladder as well as monopoly games principles were used. The five aspects which were considered by the lecturers when designing the radiography board game are a) definition of the specific outcomes, b) game rules and ground rules for the players, c) there must be feedback on progress, d) participation must be voluntary and finally, e) the game must have a flow (Cain & Piascik, 2015). Among these five aspects which were considered in the design of the radiography board game, the fourth one would be applicable in the case of a research study but, not if the board game has been identified as a learning tool. The MDA framework of game design and development as adopted by most researchers in gamification; Kim (2015); Robson et al., (2015); Grey et al (2017) were taken into consideration. Game mechanics are discussed first.

1.3.1 Game Mechanics

Game mechanics are described as the organisational rules that guides and provides structure to the game by outlining what is expected from the students in order to win (Robson et al, 2015) This includes rules, time limits, progression details, rewards and penalties (Robson et al., 2015). In this pilot study the researchers developed the game rules and made these available on a card with the game accessories. The game was designed in a way that it will allow maximum of four players at a time. The progression details were as follows; a) you are required to throw a dice and move your marker on the board according to the number indicated, b) pick up a card corresponding to the colour of the block that you landed on, c) read your question out loud and provide an answer, d) you can seek the help from your group members if necessary, e) check if your answer is correct on the reverse side of the card, f) if you answered correctly, you are to move a step forward. If your answer was incorrect, then you remain in the same place. Just to elaborate on point d), and the main objective of this game being to evoke learning, whenever a student does not know the answer, he or she can discuss the questions with the other players. This was meant to maintain and enhance engagement with learning. The competitiveness was maintained, by virtue of the player not progressing forward. Rewards and penalties were also incorporated. This included awards for good and bad job stations, each resulting in the participants being able to progress up on the ladder or to regress down the ladder, respectively. Previous studies state that the inclusion of this aspect is an important part of gamification as it acclimatises the students to certain professional behaviours, signalling a reward and thus progression, or penalty and regression as it would naturally occur in real life (Elverdam & Aarseth, 2007; Robson et al., 2015).

1.3.2 Game dynamics

Game dynamics, unlike mechanics, relates to the types of behaviour that emerge as plyers engage with the game (Robson,et al., 2015). The authors list the following as possible game dynamics, namely; “cheating, conspiring, lying, bragging or disinterest when loosing” which may have a positive or negative outlook on the game by the students. Positive student engagement, is reported by Shernoff et al., 2016 as having shown to improve academic performance and is therefore an essential aspect in the gamification arena. To ensure positive game dynamics, these authors recommend that the game board designers, develop mechanics that

can address the above mentioned dynamics. From the views of Schell (2008) game designers are reminded that the game is not an experience, but an experience enabler. According to Kim (2015), dynamics is a system that creates a desirable game experience for the players. The author goes on to say that there must be time pressure to support the aesthetic challenge. People take part in a game to win or beat their opponents. In this pilot study, the researchers strategically placed good and bad job cards as rewards or penalties where the student will go down the ladder if they land on the bad job or go up the ladder if he or she lands on the good job. The radiography board game was also designed in a way that prevented the student from progressing up the ladder if the question was incorrectly answered. The opposite meant that the student who answered correctly, will progress up the ladder. Another aspect that was built into the game, was the opportunity to allow for student engagement. The students were encouraged to discuss the questions and answers in the process.

1.3.3 Aesthetics

Aesthetical appearance of any activity is likely to spark more interest in engaging with the content. To ensure that students have fun whilst learning, it is imperative the game has elements of excitement, wonder and engagement (Hunicke, et al., 2004; Bohyun, 2015; and Browning, 2016). In this pilot study the game board made use of different coloured spinal vertebrae as blocks with scattered radiographic images throughout the board, see figure 1. The colours chosen for the questions were, yellow, blue and red, each representing a different degree of complexity according to Blooms Taxonomy. Anderson et al., 2001 as questions progressed upward in the spiral shape. The yellow blocks were designed for lower order thinking, aimed at recalling basic facts and concepts. The blue blocks were designed for analysing and interpreting and included radiographic images. Lastly the red blocks were designed for higher order thinking that called for critical analysis of concepts. Schell (2008) describe aesthetics as the part of the game that the players sees and should therefore be appealing. This author describes the four important parts of game design, called the tetrad elements as aesthetics,

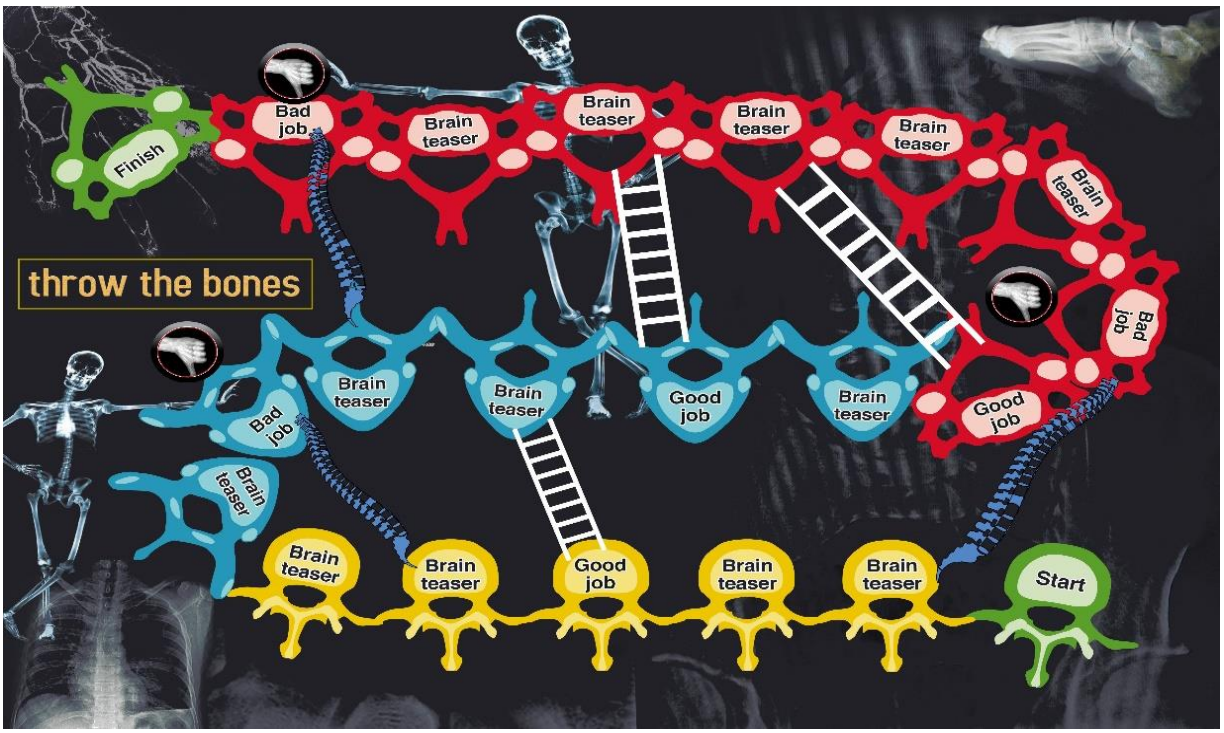

Figure 1: Radiography board game design

mechanics, story, and technology. Schell (2008) further states that the four elements must be used in a harmonious way to ensure that they support one another. This brings us to the fourth design element, the goal or outcome.

1.3.4 Goal

Browning (2016) introduced the concept of MDAO, which stands for mechanics, dynamics, aesthetics and outcomes. According to this author, games are a successful pedagogical tool to change attitudes and behaviour. It is therefore important that the players in the game, be kept motivated. The author also recommends that game designers should always ensure that the games are both intrinsically motivating by focusing on the interplay between the outcomes and the other three elements of the design framework, namely; mechanics, dynamics and aesthetics. Grey et al.,(2017) support the need to address the goal of designing a game for teaching purposes. These authors say, by integrating learning outcomes into the game mechanics, then experience of playing a game as well as understanding the strategies available to achieve the set goals, can become a genuine learning experience. As demonstrated in the radiography board game in figure 1, attempts were made to ensure that all elements of the framework are incorporated. In addition to incorporating the principle elements of game design, the radiography board game also took Schell (2008) recommendations into consideration. The game was designed with the focus on the player and also ensuring that the player is kept focused on the game and expected outcomes, while enjoying the pleasure of engaging in the game and hopefully, learning as well.

1.3.5 Radiographic technique content developed for the game

As soon as the researchers were done with the design of the game board, they utilised approach three, as described by Kickmeier-Rust and Albert (2012), and involved the graphic designers in the faculty, in the

design of the board game content. The process of developing the question cards was guided by the colour presentation of the level of complexity. As shown in figure two, the level of complexity in the questions asked ranged from low level (yellow) to moderate (blue) and high (red), see figure 2. All cards had the answers printed at the reverse side. Lecturers involved in teaching the Radiographic Technique module, constructed different sets of questions, according to the three levels of study, that is, from the first, second to the third year. Some of these questions were derived from the prescribed and recommended literature and others were based on case scenarios from the clinical radiography environment. This phase of the development of the game board was the most labour intensive as it required meticulous attention to detail in the questions and answers as well as the actual making of the cards. Making the cards encompassed cutting and laminating 8cm x 8cm cards and creating packs for each game board. The design and implementation phase was carried out over five months. Good interpersonal relations played a big role.

BRAIN TEASER	**BRAIN TEASER**	**BRAIN TEASER**
Which of the following imaging modalities is most sensitive in diagnosing early signs of metastatic carcinoma a) Magnetic Resonance Imaging b) Sonography c) Computed Tomography	Name the structure that the arrows are pointing to 	A 2 year old child with a clinical history of Non-accidental injury is referred to the radiography department for a full skeletal survey. Would advice for or against a skeletal survey?

Figure 2. Examples of the question cards according to the level of complexity.

2. Research methodology

The pilot study took the form of a qualitative, exploratory descriptive design. Exploratory designs begin with a phenomenon of interest that is not well understood whereby the researcher wants to investigate the full extent of the area of interest (Polit and Beck, 2017). According to de Vos, Strydom, Founché & Delport, (De Vos, 2011). An exploratory design was therefore found to be appropriate in this study as its aim was to explore how the radiography students experienced the radiography board with regards to teaching and learning in the radiography technique module. With regards to the descriptive nature of the study, De Vos et al, (2011) present exploratory and descriptive designs as being somehow similar. The authors further demonstrate the difference in that the descriptive designs are said to present a picture of a specific details

of a situation, as it is the case with this pilot study. Due to the qualitative nature of the study, purposive sampling was used. This is a non-probability sampling strategy that is described by De Vos et al.(De Vos, 2011) as being judgemental because the researcher identifies participants that are mostly appropriate for a particular study. As already mentioned, the first, second and third year students were invited to participate voluntarily in the radiography board game activity. Participation in the groups was also according to the year of study. This was maintained during both the board game activity and the focus group interviews. The objective was to later compare and contrast the views through data triangulation.

2.1 Research participants

The sample comprised of total of 35 radiography students who volunteered to participate in the board game research. As already indicated, three categories of students, namely; first, second and third years were invited to participate in this study. There were 11 first years, 12 second years, and 12 third years. Seven focus group interviews were conducted. The reason why all three categories were invited is because the radiography technique module is the major subject that is offered from the first year of study, through to the third year. As this was a pilot project, the researchers deemed it necessary that all year groups be invited to participate. Their experiences with the board game will inform the lecturers if this teaching and learning intervention can be introduced in all study years.

2.2 Data collection and analysis

Ethical approval was granted by the University's Faculty of Health Science, ethics committee, (426/2017). Participants also signed the consent form, agreeing to participate in the board game activity and the focus group interview. Secondly, the participants consented to have the focus group interviews audio recorded. The other measure put in place was to have two research assistants to oversee the radiography board game activity. The two assistants were not lecturers and were regarded as neutral as far as the study was concerned. Participation in the radiography board game activity took about fifteen to thirty minutes for each group. The different groups of students in any study year, played at the same time, in one venue, under the supervision of the research assistants.

Following the board game activity, data was collected from the three categories of students through focus group interviews. There were two groups of first year students, two groups of second years and three groups of third years. This research instrument was found to be appropriate because it allowed the participants to interact on how they experienced the board game. As stated by Creswell (Creswell , 2017), the interview can also be regarded as a conversation with a specific focus, where the overall experience is reflected upon.

A set of semi-structured questions were used to guide the focus group interviews. This was necessary to ensure that all groups remained focused on the objective of the pilot study. It is also because the focus group interviews were facilitated by the different lecturers. Audio recorded data was transcribed verbatim by an independent person. The transcribed data was presented according to the different year groups. Qualitative content analysis was used for the identification of codes and categories. This approach was appropriate for this pilot study because of the need to gather understanding (Vaismoradi, Turunen, &

Bondas, 2013) how the students experienced the radiography board game. An attempt was made to triangulate data from the three groups of students. Three major themes that emerged from this pilot study all relate to how the participants described the radiography board game. To make meaning from the emerging themes, the findings are presented next.

3. Research findings

Interrogation of the emerging themes, which were also related to the voices of the participants (Denzin 2017), lead to the following four major findings, namely a) a board game that has been specifically designed for the radiography, does contribute to learning in the first, second and third year of the radiographic technique module; b) depending on how the questions are phrased, the radiography board game can also serve as a teaching and assessment tool, c) there are some aspects that need to addressed, in order to maximise the benefits of using the board game in the radiographic technique module; and d) there are other opportunities for which this board game can be used in the teaching and learning environment, and this is not limited to the radiographic technique module or radiography programme only. Each finding is elaborated on as follows.

3.1 Radiography board game does contribute to learning in the first, second and third year of the radiographic technique module

Following the analysis of data, it became evident that the student's find the board game as a tool that can enhance their learning on different aspects. Starting with the opportunity to encourage engagement and discussion among the groups. A first year student indicated that, despite having no specific questions that requested discussions, "the game itself prompted discussions" among the team players. This was echoed by the third year student who indicated that "as you struggle to remember the answer to the question on your card, other team players, try to prompt you to remember and at times, it leads to discussions on the specific question". The types of questions asked helped the students to integrate theory into practice. First year student saw this opportunity from the "good job/bad job" that was built into the game. The participant said "these make you focus on your work in the clinical environment." From the second years perspective, one participant commented about the "different colours that make you remember things" as well as the levels of the questions, that was form easy, moderate to more challenging questions." Participants from the second years and third year categories indicated that the board game would work well as a revision tool before the tests or examinations. From the views expressed by the participants, the radiography board game makes learning fun as it encourages one to do, discover, process and apply new information, which will eventually contribute to memory development. Learning in a fun way aligns well with what Schell (2008) say about gaming that provides a holistic way to understand a complex system of relationships and improves understanding. Relating to what Grey et al., (Grey et al., 2017) say about gaming, the board game has proven to provide support for practical application and experiential learning.

3.2 The radiography board game can also serve as a teaching and assessment tool

Radiographic technique module has the theoretical and practical components and hence, the offering that is conducted in a work-integrated learning environment. Looking at the radiography board game as a teaching tool that can also be used in assessments, means it should address both the theory and practice. Beginning with teaching in healthcare sciences, Bensinger (Bensinger, 2015) describes the challenges associated with teaching nursing students how to become critical thinkers. Relating this to the current study, it was mentioned by the participants in this pilot study that the game prompted them to engage in discussions. From the second year group of students, they indicated that scenario and practical questions, like "how to position for a skull" should be brought in. Such questions can brought in and students left alone to practice with their peers as observers or assessors. As demonstrated by Bensinger (Bensinger, 2015) through gamification, problem based learning can be used to enhance critical thinking. What also stands out about using games in the teaching environment is the immediate feedback that is given to the student. By playing the game that provides immediate feedback, makes the student know what is right and what is wrong in relation to the question or scenario provided. The use of different types of questions will also provide for theoretical and practical teaching and assessment. The participants in the pilot study said the board game would be a good revision tool. In relating this statement to Tsai, Tsai and Link (Tsai, Tsai, & Lin, 2015), formative assessment is essential because if provides immediate feedback. What can be learnt from this pilot study, is that, the game board will be useful for formative assessment, which will serve as a preparation exercise for the summative assessment. The game board can also be useful in encouraging student-centred learning through the provision of problem based activities or questions as suggested by the participants. The radiography board game will serve this purpose if the lecturers can use questions or scenarios like it is recommended by Savery (2015). This author say facilitators must provide ill structured problems that will encourage students to take responsibility for their own learning through problem identification and development of the appropriate solutions. This can also be associated with inquiry based learning or flipped classroom as described by Moffett (Moffett, 2015). This author described a flipped classroom as a situation where the students are given some task to work on activities before their actual engagement with the topic in class. Using the radiography board game this way, can also encourage inquiry-based research which is a form of student-centred approach.

3.3 There are some aspects that need to address, in order to maximise the benefits of using the board game

From the two findings presented, it is evident that the radiography board game can address the teaching and learning challenges that were highlighted by the researchers. The research participants however, highlighted some areas that needed to be improved for the board game to be utilised as a teaching and learning tool for the radiographic technique module. Some of the points that seemed common to all three categories of participants were, a) the game is too short, and there is need for more and challenging questions to evoke discussions. The second and third year's students also alluded to the issue about the rules. With regards to the rules, it is clear that the students are familiar with the snakes and ladder game. They know the rules and when one gets awards or penalties. As the third years indicated, the rule as to

when must one move up or down the ladder of the board game was not very clear. The participants, however, acknowledged the inclusion of good job/bad job. One first year student said, this type of reward/penalty in the game makes one focus more on the work in the clinical environment. From the third years, this was regarded as being good for teaching professional attitudes. The one third year student, added by saying that, good job/bad job must remain part of the game, but be made more interesting. All the points highlighted as needing improvement happen to be part of mechanics as alluded to in literature. Grey et al.,(Grey et al., 2017) gives this caution to the game designers. The educational game is designed as a learning experience for people. The people playing the game are most likely going to experience the game differently. It is for this reason that the dynamics are part of the framework. Grey et al., (Grey et al., 2017) go on to propose that when designing game based learning experiences, the learning outcomes should be intrinsically integrated into the core mechanics. This is to ensure that actual learning takes place and not just compliance with the rules of the game. With the views presented by the participants, it is important that they be taken into consideration. This aligns with the recommendation by Kim (2015) that the perspectives of the players must be taken into consideration when designing games.

3.4 There are other opportunities for which this board game can be used in the teaching and learning environment

Our students recommended addition of more cards in the board game to make it more interesting and more challenging so that there is a large data bank of questions available. They also recommended that the board game have more blocks that make up the board to increase the game time. Board games are rule-based systems and require players to do the work that can be done by a computer in a video or console-based game. Debugging is a component of computational thinking across numerous game settings and it can be associated with the process of learning and internalizing rules. The authors Berland and Lee (2011), like the students in this study, recommended that the instructional design associated with board game based computational thinking be turned into a digital media computational literacy.

4 Discussion

Literature on educational gaming has now adopted a term, serious gaming. This term seem to relate well to the activities around this radiography board game, from its design, implementation as well as the evaluation of the outcomes. Serious games have education as their primary goal, as opposed to entertainment (Margarida et al., 2015)(Romaro, Usart and Oh, 2015). Games by definition are something we play, offering the opportunity to think, react, adapt, master, compete, and laugh all the way through. Treher (2011) list the three myths about learning to help highlight why board games contribute to effective learning. The three beliefs and myths are listen to an expert, experience leads to learning and hands on-learning works best. These statements can be related to experimental learning as it is used in the radiography module where it was demonstrated that students only engage with the learning task in the clinical environment, when it is due for submission. In her study, Treher (2011) demonstrates that hands-on and heads-on together leads to effective learning. The author go on to say that board games can be helpful in building social skills and self-esteem, as well as teach about rules, competition, fair play, and

values and healthy competitive environment. This experience is supported by the participants in this study, who say, the game provided the opportunity for other team members to assist where one did not know the answer. A game is a problem solving activity approached with a tactful attitude (Schell & Schell, 2008). This author goes on to say that the game must have an endogenous value to the player and also keep the player motivated to carry on with the engagement. From this pilot study, the following features of the radiography board game became explicit.

4.1 The game would enhance inquiry-based research process

Participants in this pilot study recommended that they be given an opportunity to produce their own question bank and creating their own questions. A board game as an alternative way of engaging students, it can enhance motivation, enjoyment, and absorption. This innovative approach is embedded through teaching students how to think, solve problems, and work with their peers. It also incorporates the 21st century skills of critical thinking and problem solving, creativity and innovation, collaboration, and communication (Kelley and Knowles, 2016). Data from educational psychologists tell that people retains 80% of what they do as opposed to 10-20% of what it is heard and read. Experience by itself hardly grows into meaningful learning unless the events in such experience allow giving meaning and relevance (Treher, 2011) upon reflection and thus, developing the corresponding skill and mind set.

4.2 Board game can be used for assessments in the practical environment

As suggested by Treher (2011) games can be used as assessment tools. In relating this to the radiographic technique module, the students are expected to be able to analyse images within a specified amount of time. The students will be expected to do image analysis within five seconds, using a systematic approach that was taught in class to identify if the image is optimal or suboptimal. The game can also be changed to the five minute rule. This would entail, for example; an interpretation of a chest x-rays is carried out by identifying all abnormal patterns and giving a diagnosis within five minutes. Lots of different topics and subjects can be tested in this engaging and enjoyable game.

4.3 The board game would contribute to mental and social development:

Board games offer the opportunity for more face-to-face interaction with others, which in itself is supportive of mental health and social development (Browning, 2016). Participants in the study described the board game as being capable of bringing both qualified radiographers and all students from different year group together. Board games teach social skills such as following rules, taking turns and sharing with others, help reduce isolation and builds positive relationships with others associated with good mental health.

4.4 The radiography board game has addressed all design principles

Hunicke et l.,(2004) and Kim (2015) are some of the authors that are known for defining the MDA framework that outlines the principle involved in game design. Browning (2016) introduced the MDAO framework by highlighting the need to focus on the interplay between the outcomes and other vectors of

the design. From the views of the participants in this study, the radiography board game needs attention to be directed to the rule of the game. This is the mechanical part of the design framework. The participants indicated that the rules were at time not clear as to when must move up and down the ladder. What is important to note, is that the radiography board game had rules. The other point is that, this study was a pilot that was used to gather views and suggestions from the participants. With regards to dynamics, all categories of the participants commented on the time that was taken to play the game. Major concern was the time being too short and questions being few. The radiography board game, therefore had built in it, a system in place that created a desirable game experience for the players (Schell & Schell, 2008) (Schell, 2008; Kim, 2015). In the views of Cain and Piascid (2015), it can be said that the radiography board game incorporated rewards/ debriefing and reflection opportunities. These were built in in the form of bad job/good job in the radiography board game. The third principle in design is aesthetics. The colours were regarded by the participants as attractive and stimulating one to remember questions. A second year participant said, remembering things was made easy due to the many colours. The other second year referred to the colour-coded levels of the questions which also helped the student in linking theory to practice. The last principle that the radiography board game fulfilled is addressing the learning outcomes.

4. Conclusion

The experiences of the participants in this study support the use of the radiography board game as a teaching and learning tool that can be used in both theory and practice. The participants further indicated that there were areas that needed improvement. In addition to these, the participants expressed that the board game as designed for the radiographic technique module, can be adapted for use in other modules. The examples of modules for which similar games could be designed were; Anatomy, Physiology as well as radiographic Imaging. The students were however less positive about such a game being useful for modules like Physics because of the many calculations involved. As literature has shown, board games are an important tool to provide hands-on and heads-on skill and knowledge development for people of all ages on different subjects. Well-designed educational games create an engaging atmosphere, provide a playful, yet competitive environment in which to focus on content, reinforce and apply learning. Mistakes are useful and point out what we need to learn. The board game itself provides a visual metaphor to help connect information.

Game elements, discussions, and problem solving with fellow team members about the content are vehicles for learning. Good questions, problems to solve, and situations to consider allow players to think through and apply what they learn. In addition to requiring critical thinking, team-based board games help to build communication and relationship skills as players work face-to-face to answer questions or solve problems and see that together they often figure out something they thought they didn't know. The power of collaboration becomes apparent to all and, in organizational settings, can transform working relationships.

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