GAF: From a Conceptual Framework to a Model of Learning in Educational Gaming

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DOI: 10.34190/GBL.19.018

Abstract: There has been much debate in international literature on the effectiveness of educational games in student learning. In the field of Economics, there has been growing evidence that games are an effective teaching pedagogy in increasing motivation and the retention of knowledge. However, very little is written on 'how' and 'why' students learn from these Economics educational games. The Game Analysis Framework (GAF) was designed as a conceptual lens that would provide a method for mapping out 'how' and 'why' students learn from playing educational games. GAF was initially developed from three models of game design based on an experiential and constructivist theory of learning. However, from the results of the study, this model had to be revised as other factors such as motivation, engagement and emotions became the core drivers of learning. The study's results such as emotions necessitated a revision of the GAF model to include these new findings, highlighting the importance of non-cognitive factors in learning and how games harness these factors to create a deliberative learning environment. It also causes one to perhaps move beyond the constructivist and experiential learning paradigms of learning by doing to learning by enacting knowledge – an enactivist approach.

Keywords: educational gaming, constructivism, enactivism

1. Introduction

Educational games claim to be an effective means of passing on knowledge and skills to students, International literature has over the years shown a growing interest in using games as an instructional medium to improve learning in the classroom. Although much has been documented about the potential of games to facilitate engagement, motivation and student-centred learning, there is "little consensus on the game features that support learning effectiveness, the process by which games engage learners and the types of learning outcomes that can be achieved through game play" (Guillén-Nieto and Aleson-Carbonell, 2012, p. 435).

Most research undertaken too date has been quantitative, concentrating on the measurement of performance following the introduction of games into the classroom, by comparing these results to traditional 'chalk and talk' methods using treatment and control groups. For instance, it has been shown that the use of games to teach Economics improves student achievement (Emerson and Taylor, 2004; Ball et al., 2006); results in better retention of course material (Nkonyane and van Wyk, 2015); stimulates higher student motivation (Gremmen and van den Brekel, 2013); and, creates a favourable impression of Economics (Tsigaris, 2008). However, there is a paucity in the research with respect to specific processes that take place during the playing of the games that encourage learning to occur.

To maximise this efficacy of educational games, one needs to grapple with the manner in which educational games in the classroom trigger a unique learning system that results in deeper conceptual understanding, i.e. 'how' and 'why' students learn from the introduction of an educational gaming intervention.

This is the role for which GAF has been designed. If the learning process can be deciphered, then lecturers will be able to design and deploy games to meet the pre-planned learning outcomes of the curriculum. Such an achievement will not only lead to students attaining deeper conceptual understanding of the subject, but also engender passion, interest and a desire to know more about the subject. If used correctly, the introduction of an educational gaming intervention should enable students to traverse the boundary between the classroom and the 'real world' (i.e. linking academic theory with everyday life).

2. Initial Game Analysis Framework (GAF)

In order to evaluate the ways in which educational games create effective learning environments as well as 'how' and 'why' students learn from games, a new model has to emerge which takes cognisance of the game dynamics (flow and game cycle) and the ways in which they stimulate learning (critical thinking, discovery, goal formation, goal completion, etc). To do so, picture the perimeters of a rugby field within which the game is played. Here, the players (in this case, the students) combine various attributes to achieve successful learning outcomes. The aim of this study is to identify which attributes are generated by the game and the ways in which they fit together. This should allow for clarification on 'how' and 'why' students learn through the process of playing an educational game. The resultant conceptual model is referred to as the Game Analysis Framework (GAF). By combining facets from Garris et al.'s (2002) Input-Process-Output model, Amory and Seagram 's (2003) GOM and GAM, together with Kiili's (2005) Experiential Gaming Model, GAF intends to provide a conceptual lens through which the learning dynamics generated by the game can be identified and evaluated. The overall structure of GAF comprises three main sectors: Learning Outcomes (LO); the Game Space (GS) and Post Game Reflection (PGR), which will be applied to non-computerised educational games.

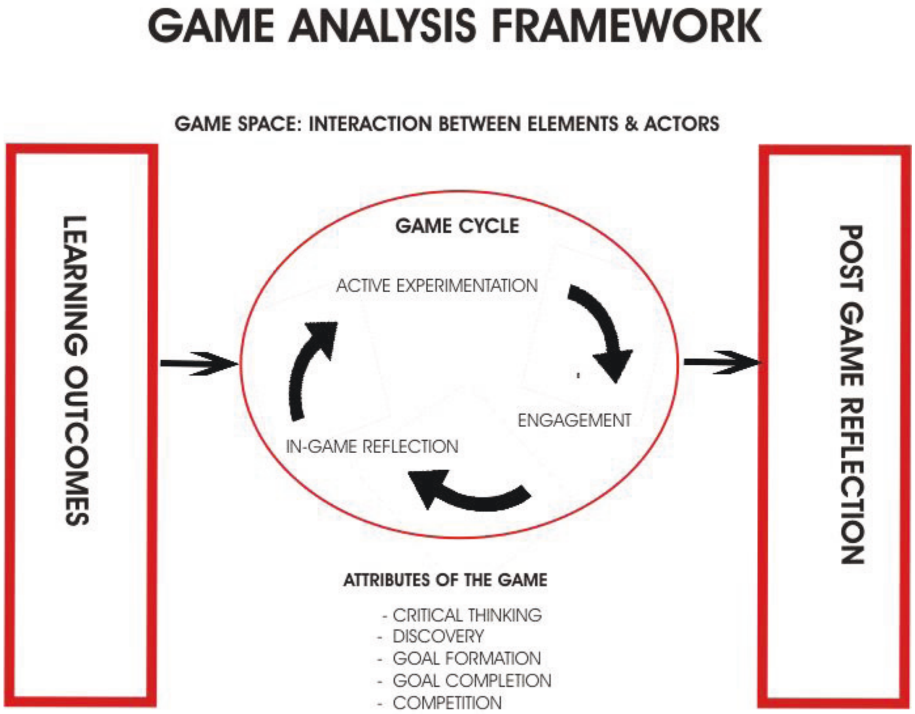

Figure 1: Initial game analysis framework

2.1 Learning Outcomes (LO)

Clearly defined learning objectives are the priority of the Learning Outcomes (LO) sector in order to develop the storyline of the game to create the challenge provided by the Game Space (GS). To maintain the flow of the motivation and engagement of students, there needs to be a balance between the learning objectives and the challenges of the game. As part of this process, the challenges need to be relevant to the students, embedded in the curriculum and have 'real world' applicability.

2.2 Game Space (GS)

Within the Game Space (GS), the players interact with the elements of the game, triggering the three stages of the gaming cycle, namely i) engagement; ii) in-game reflection; and iii) active experimentation. Together, they mesh the pedagogical elements with the gaming mechanics to create the learning cycle through which each player moves in the gaming environment. The process initiates the engagement of the player who becomes immersed through the storyline as the challenges of the game are overcome. The players, through in-game reflection, begin to brainstorm and develop ideas in response to the challenges.

The final stage of the game cycle, active experimentation, is where the ideas are developed into hypotheses, tested and modified after receiving feedback from the game. During this stage, players begin to plan their actions around the storyline devised in LO. This interaction between the players and the elements of the game results in flow (increased motivation and engagement) and the acquisition of the attributes of learning, such as goal formation and critical thinking, amongst others. This cycle is repeated as the player progresses from one challenge to the next.

To maintain the flow, there needs to be a balance between the learning objectives (LO) and the challenges of the game in order to ensure that students remain motivated and engaged. This interaction between LO and the GS provides the means to study 'how' and 'why' students learn from the playing of educational games.

2.3 Post Game Reflection (PGR)

This sector encourages players and the facilitator to critically reflect on the game in terms of whether it was effective in achieving the learning outcomes. Post-Game Reflection (PGR) has been highlighted by Garris et al. (2002) as an integral part of the learning process, in which the players reflect and analyse their actions under the guidance of the facilitator, who also assists them to bridge the divide between the gaming experience and the 'real world'. In this way, PGR maximizes the learning potential of the game. Cartwright and Stepanova (2012), who examined the use of classroom experiments (games) to teach Economics, were of the opinion that encouraging reflection on a game and analysing the experience "appears to significantly increase the amount of economics they learn" (Cartwright and Stepanova, 2012, p. 49).

The reason for dividing GAF into three distinct sectors is that each stage can be analysed separately, as well as in conjunction with each other in order to determine how they impact on the learning process during the game. Various aspects come under scrutiny, such as (i) whether the interaction between the players and the elements is strong enough to keep them immersed; (ii) whether the game resulted in the acquisition of the attributes of learning (i.e. critical thinking and discovery amongst others); and (iii) ultimately, whether the game resulted in achieving the learning objectives as defined by the LO sector.

2.4 Thoughts on the framework

GAF places the learning objectives that are to be achieved through the playing of the game at the forefront of the process, based on the Input-Process-Outcome Gaming Model (Garris et al., 2002). This is because clear learning goals need to be embedded into the gaming mechanics and are therefore essential for the efficacy of the gaming intervention. In addition, the melding together of the game mechanics with the learning goals needs to strike a balance between being challenging and yet not too difficult or too easy so that students remain engaged. For this reason, the demographics of students in the classroom need to be taken into consideration during game design.

GAF comprises of static and dynamic sectors where LO and PGR are static (goal posts) and GS is dynamic (the field of play). The GS is a fusion of Garris et al.'s (2002) game cycle and Amory and Seagram's (2003) 'actors' (players) and 'elements' (game mechanics). This amalgam allows for the generation of learning attributes such as critical thinking, discovery, goal formation, goal completion and competition. Within the gaming cycle, players become immersed in the game, triggering the flow (increased motivation and engagement) through play (Kiili, 2005).

The final sector, PGR, brings together suggestions from all three models that upon completion of the game there needs to be a facilitated feedback session where the players can reflect upon their learning experience and connect it to the 'real world' under the auspices of the facilitator.

3. Research

The research that followed was a qualitative study that involving 14 randomly selected participants from a group of 120 who experienced an Economics gaming intervention. The gaming intervention consisted of three games all of which were designed by academics and available for free of charge. The first game of the educational gaming intervention was an adaptation of Holt's (1996) 'Trading in a Pit Market', with the learning outcome being how markets reach equilibrium through the interaction of buyers (demand) and sellers (supply).

The second game was based on Kruse, Ozdemir and Thompson's 'Market Forces and Price Ceilings: A Classroom Experiment' (2005), with the aim of showing students the effect of a price ceiling on a market.

The third and final game of the Economics gaming intervention was used to provide students with a tangible experience of the Law of Diminishing Returns. To do this, 'Widget Production in the Classroom' (Neral, 1993) had to be adapted to accommodate the large size of the class.

The methodological basis for this study utilises Interactive Qualitative Analysis (IQA) and the derived results are bolstered by the participants' views of each game after participating in the Economics gaming intervention, which have been captured in their reflective journals. The first phase of the IQA process utilises focus groups in which the participants (constituents) "themselves perform the first steps of analysis by organizing their discourse into categories of meaning called affinities" (Northcutt and McCoy, 2004, p. 44). The causal relationships between the affinities are then mapped out by the participants, from which a conceptual map is derived. This is referred to as an Inter-relationship Diagram (IRD). Taking these relationships one step further, a Systems Influence Diagram (SID) is constructed, the final product of IQA. This is a visual representation of the drivers and the outcomes: the influences between the affinities, causes and effects.

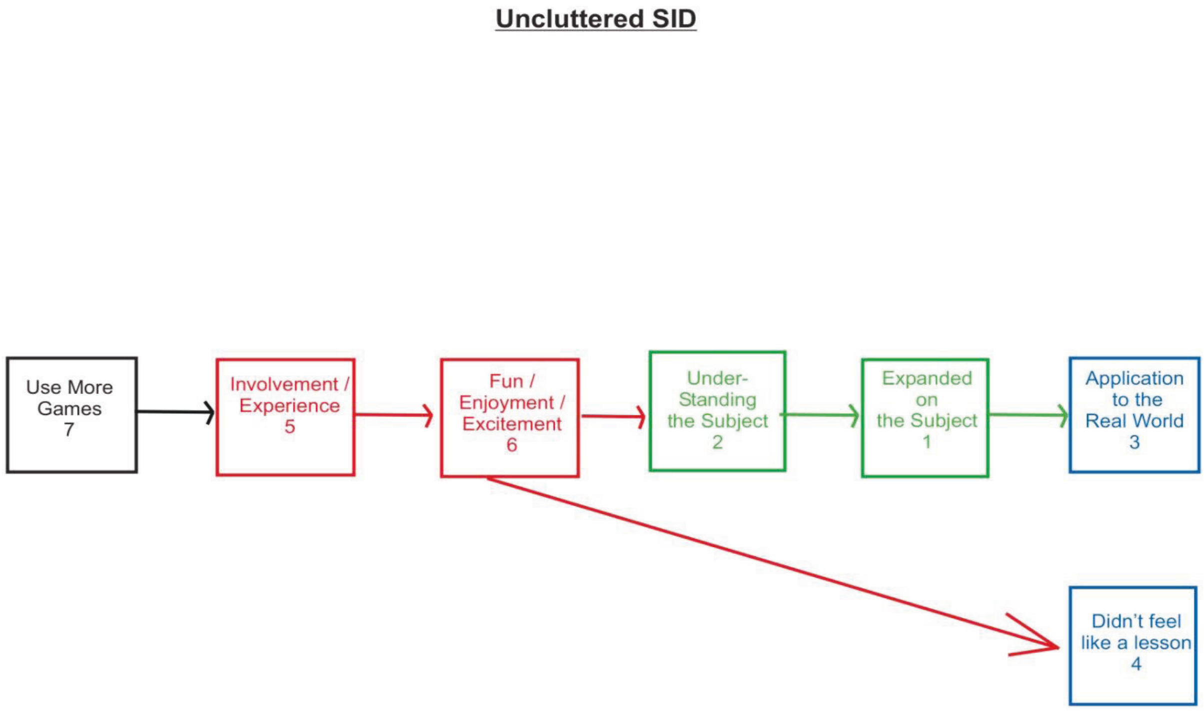

Figure 2: The uncluttered systems influence diagram

3.1 Concluding the journey: A tour through the system

'Use More Games' emerged as the Primary Driver for 'how' the students learned from the Economics gaming intervention. According to them, the use of games was the catalyst for creating a dynamic, vibrant learning environment which was conducive to deepening and internalising their conceptual knowledge.

Two crucial components which emerged as secondary drivers were the students' 'Involvement/ Experience' and 'Fun/ Enjoyment/ Excitement'. By becoming direct participants in generating and analysing the data that they produced, the students became co-creators of knowledge.

This 'Involvement/ Experience' was directly responsible for introducing the element of 'Fun/ Enjoyment/ Excitement' into the Economics classroom. The vibrancy and interactivity resulted in students becoming more engaged in the lesson; more interested in the Economics topics; and ultimately, able to remember more of what they had learned. This in turn led to a greater understanding of the subject (Affinity: Understanding the Subject). The internalisation and assimilation of knowledge gave students the confidence to interpret and explain the Economics concepts in their own words, as the concepts now had meaning and purpose. By 'Expanding on the Subject', students were placed into a context where they could see the theory in action, which brought meaning and substance to otherwise abstract concepts: 'why' they learned from playing Economics games in the classroom.

The first primary outcome of the gaming intervention, 'Application to the Real World', was that students were now able to relate economic concepts to the 'real world' (i.e. they had taken the theory from the abstract to concrete reality and were now able to see real-life application).

The 'Fun/ Enjoyment/ Excitement' in the classroom was directly linked to a separate primary outcome, namely 'Didn't Feel Like a Lesson'. Here, the emphasis was on the disruption of the traditional lecture format caused by the introduction of the gaming intervention. Such a disruption brought about a learning environment in which students felt freed of traditional classroom constraints, to one where they were able to interact with each other; personalise their learning; and naturally retain what they had learned.

Although there are two separate primary outcomes, they possess a common thread, namely that in both cases students' conceptual knowledge was deepened.

4. Reconstructing GAF: Adding complexity

Taking into consideration that GAF was created as an initial lens through which to view 'how' and 'why' students learn from educational games prior to the research being undertaken, the framework is too rigid and simplistic and therefore needs to be re-worked. It inadequately explains the complex and interrelated nature of the learning process. On the contrary, the processes described by the initial GAF model are not irrelevant, but they are simply too reductionistic to accurately capture students' journey to deeper conceptual understanding. The IQA findings have revealed that deeper conceptual understanding can only be attained if the roles of engagement and positive emotions are also taken into consideration. The two goal posts (Learning Outcomes and Post Game Reflection) remain as prescribed. However, the processes that explain 'how' and 'why' students learn from educational games are far more complex and need to be revisited.

Within the Game Space (between the two goal posts), the acquisition of knowledge cannot be explained by the Game Cycle alone as students have to be enticed to buy-in to the gaming process before unlocking deeper conceptual understanding. This educational environment has to foster engagement on a behavioural and emotional level. To activate the learning cycle, drivers revealed by the IQA process, namely 'Use more Games'; 'Involvement/Experience'; and 'Fun/Enjoyment/ Excitement' are essential as they explain 'how' students learn from educational games. The first of these, 'Use More Games', is the catalyst that enables an environment where active learning can take place, providing for the disruption of the traditional academic flow. Now, instead of sitting and listening, students are placed at the centre of the learning environment, gaining hands-on experience where they grapple with ideas, complexity and uncertainty.

The secondary drivers, namely 'Involvement/Experience' and 'Fun/ Enjoyment/ Excitement' provide the momentum that propels the student towards deeper conceptual understanding. 'Involvement/ Experience' has been shown by the students to be a necessary condition for the learning process to gain traction. Moving beyond just being about participation and interaction, the concept of 'Involvement/ Experience' through the medium of the game provides the students with autonomy, competence and relatedness that lead, according to the Self-determination Theory (Ryan and Deci, 2000), to becoming motivated and engaged.

As a result of the buy-in to the learning process, the intrinsically motivated students rallied to overcome the challenges of the game. This was the springboard for the emergence of the next secondary driver – 'Fun/ Enjoyment/ Excitement', as they visibly enjoyed having to grapple with the problems at hand. In this way, they were enabled to make the connections between the academic theory and its practical application. This newly-discovered excitement about learning Economics seemed to open their minds to new possibilities of relating and weaving together the theoretical concepts and being able to relate them to occurrences in the 'real world'. This paved the way for the transition towards deeper conceptual understanding. In other words, 'why' they learned from the educational Economics games.

4.1 Reciprocity

The secondary drivers, 'Involvement/ Experience' and 'Fun/ Enjoyment/ Excitement' have a reciprocal relationship and feed off each other. Engagement with the game initiates momentum, which in turn generates the 'fun/enjoyment/excitement' that motivates students to desire a greater level of involvement. This in turn leads to more fun, etc. The correct combination of involvement and fun is key to unlocking the process of deeper conceptual understanding. By reconstructing GAF to take these drivers and their reciprocal relationships into consideration, one can see that the attainment of deeper conceptual understanding is far more complex than originally depicted. It is a product of a learning environment that engages the whole student at the physical, psychological and emotional levels. The advantage that the gaming environment has over traditional academic settings is its ability to draw students into, and immerse them in, the learning environment so that they are emotionally, behaviourally and cognitively engaged. There is more going on than just the construction of knowledge or learning by doing, as this has been augmented by the enactment of knowledge that allows for the development of cognitive strategies and reasoning which are incorporated into their way of thinking and reflecting on the world.

4.2 Reformulating the game cycle

The picture has changed and the Game Cycle is no longer the centre piece of the model. It now depicts the drivers ('how' deeper conceptual understanding is attained) and outcomes ('why' deeper conceptual understanding is attained), i.e. 'how' and 'why' students learn from playing educational games. As mentioned above, the process is driven by the reciprocal relationship between 'Involvement/ Experience' and 'Fun/ Enjoyment/ Excitement', resulting in deeper conceptual understanding. The outcomes then explain why deeper conceptual understanding opens the door to 'Understanding the Subject'- conceptual realisation; 'Expanding on the Subject' – conceptual awareness; and 'Application to the Real World'- conceptual integration. The simple mechanistic description of the Game Cycle (based on Experiential Learning and its components), namely engagement, in-game reflection and active experimentation cannot by themselves adequately capture the complex reality of the learning process that takes place within the gaming intervention. Therefore, reflecting on 'why' students learn from educational games, one has to further examine the role played by deeper conceptual understanding in unlocking access to knowledge that transcends the division between academia and the real world. It is only once the 'aha' moment has been reached that students are able to integrate their knowledge and become aware of its applicability to their everyday lives. In other words, there is a crystallisation and clarity of ideas that allows for the discovery of the patterns and elements that imbue knowledge with meaning and relevance beyond the classroom.

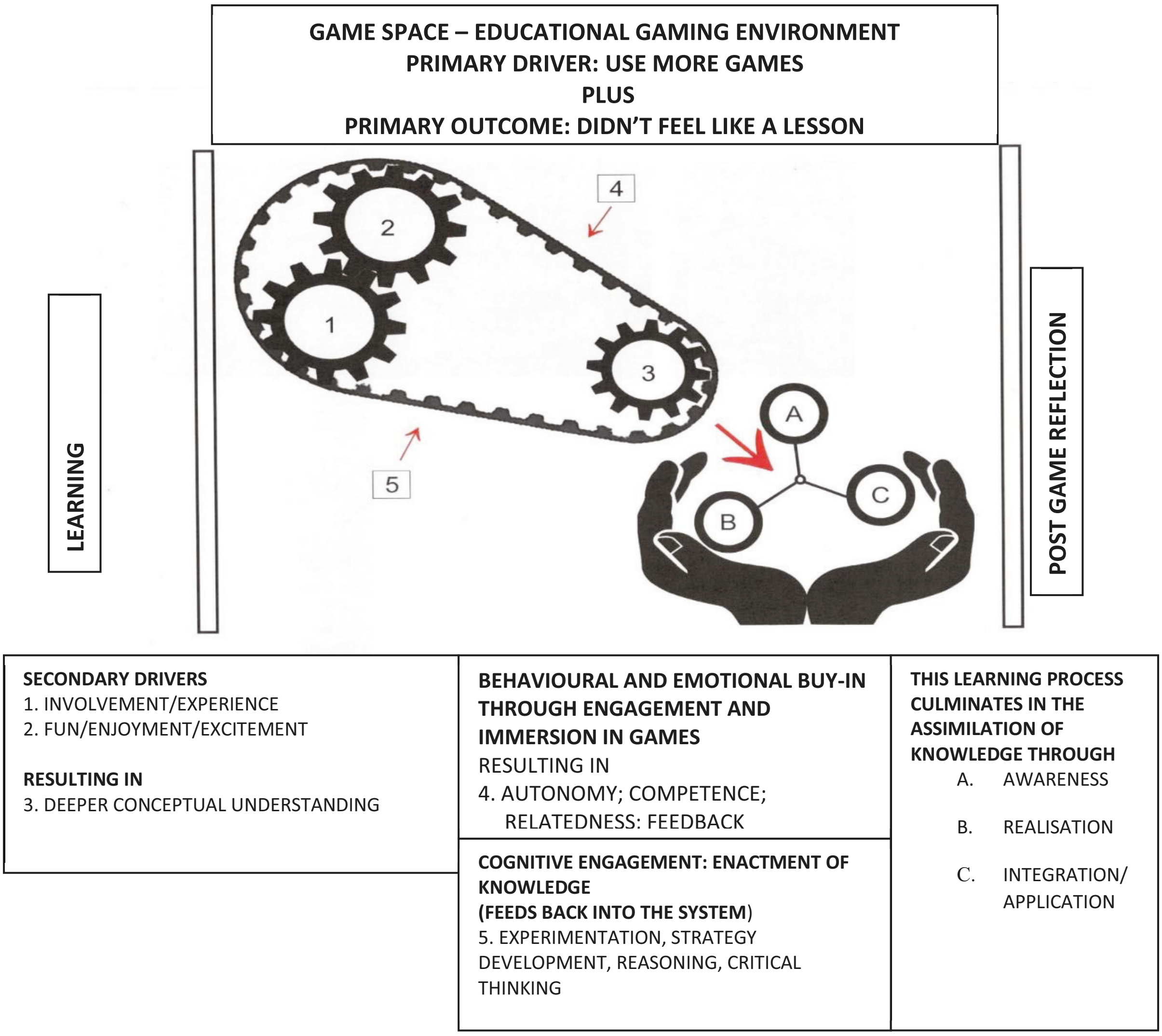

Figure 3: Game analysis framework -reconstructed

5. GAF reconstructed

As depicted in the initial GAF model, the learning process from the gaming activity occurs between two pillars, namely Learning Outcomes and Post Game Reflection, both of which remain essential components as they provide the structure within which the deliberative activity and transformational play take place. The Learning Outcomes provide the starting point where the challenges are set and embedded with educational outcomes, whilst the Post Game Reflection represents the discussion linking the gaming challenges with the educational outcomes to ensure that a deeper conceptual understanding of the concepts has been attained, i.e. ensuring the efficacy of the educational gaming intervention.

Between the two pillars is the learning environment, which is represented by the Game Space within which the gaming activity takes place. The primary driver revealed by the IQA process - 'Use More Games' and the primary outcome - 'Didn't Feel Like a Lesson' are catalysts of the Game Space and it is their interaction that facilitates the disruption of the traditional educational learning space by introducing active learning into the classroom.

Within this Game Space, 'how' and 'why' students learn from an educational gaming activity can be depicted, derived from the findings of this research. This takes the form of two processes, the first of which is a cogs-and-belt system that unlocks the 'safe' of deeper conceptual understanding ('how') and the second illustrates 'why' students learn from the educational gaming intervention after reaching that 'aha' moment.

5.1 'How' students learn from educational games

The cogs-and-belt system is driven by two main cogs, the first of which - 'Involvement/ Experience' initiates the momentum of the belt-driven system by interlinking directly with the second cog – 'Fun/ Enjoyment/ Experience'. This is a reciprocal relationship where their combined interaction adds greater traction to the learning process. This traction, in turn, sets the belt in motion which drives the third cog, namely 'deeper conceptual understanding'. Once the belt is in motion, this becomes a continuous process driven by the cogs.

The belt itself comprises two components - behavioural and emotional engagement (4) and the enactment of knowledge (5). The former, behavioural and emotional buy-in, immerses students in the gaming process by encouraging autonomy, facilitating competence and relatedness that is complemented by immediate feedback. This then leads to the second stage – the enactment of knowledge that allows for cognitive engagement which includes experimentation, strategy development, goal formation, reasoning and critical thinking that then loop into the system.

5.2 'Why' students learn from educational games

Students, through this educational gaming intervention, are now empowered to take ownership of this deeper conceptual understanding and personalise it, as their knowledge is no longer merely academic. The game has provided the means for them to link the theory to everyday occurrences in the real world. The illustration now depicts this access to awareness, realisation and integration/application unlocked by deeper conceptual understanding, which is within the hands of the students, who are then enabled to create personalised meaning of the theoretical concepts.

Whereas the Game Cycle in the initial GAF model was depicted by a cyclical process, the combination of awareness, realisation and integration/application (within the reconstructed model) occurs without any pre-determined order. As this is a personalised learning experience where students are in control of their own learning, they make their own decisions about the processes and the order in which they occur as the setting is no longer prescriptive.

6. Conclusion

An active learning environment lies at the core of 'how' and 'why' students learn from educational games. Not only is this an autonomous setting where they are the agents of their own learning, but it also provides the structure essential to attain the pre-determined learning outcomes. Being a deliberative activity with transformational play, games foster persistent, motivated and engaged students who are self-determined learners. However, this can only occur with the buy-in from students on a cognitive, emotional and behavioural level so that they can immerse themselves in the games.

This engagement adds an element of enjoyment elicited by positive emotions that assist in enhancing their problem-solving skills, encouraging reflection and focussing their attention on learning. These are the keys to successfully attaining a deeper conceptual understanding, which is a product of the melding of conceptual realisation, awareness and integration with which students can traverse the boundaries of the academic setting and apply what they have learned to new contexts and settings in their everyday lives.

7. Beyond the lenses of constructivism and experiential learning

The initial GAF model was constructed by combining experiential (Kiili, 2005) and constructivist (Amory and Seagram, 2003) approaches to learning. This seemed to provide an explanation of what was happening in terms of learning by doing (i.e. the students being able to construct their own meaning from the gaming intervention because the theory was now visible and practical). Both of these theories have not only placed the student at the centre of learning, but have also contributed towards changing the teaching paradigm from being teacher-centred to learner-centred. However, the other two pivotal areas in terms of the roles of engagement and positive emotions which have emerged in this study cannot be adequately explained using these theories alone.

This is perhaps due to both theories revolving around cognition and learning occurring as separate acts undertaken by individuals within the mental realm, splitting the individual from the world and dividing it into two: "students lived experience and cultural world" (Van den Berg, 2013). This is taken one step further where learning is simplified to a deterministic cycle with a pre-determined sequence of occurrences. For example, in the original GAF model, the cyclical pattern of engagement, in-game reflection, and active experimentation is neatly mapped out.

As the research progressed, new findings arose that led me to question the simplistically cyclical nature of the process of learning through the playing of educational games. I came to the realisation that learning is not simply dependant on mental effort alone, but is far more complex. It requires more than just constructing knowledge and learning by doing. Rather, students need to be enabled to visibly and tangibly become immersed in the learning process by enacting the academic theory, i.e. the "student does not merely observe a dynamic system, but takes over the role of one of the elements and re-enacts and controls its behavior, observing the effects on the rest of the system" (Holton, 2010, p.9). This is the role which an educational gaming intervention successfully accomplishes by making knowledge actionable, thereby providing meaning and relevance to the theory, likened by one of the research participants to placing a remote control in the hands of the students where they could press the buttons and see the outcomes within the game. This process of enactment in the game, I believe, is what enabled the students to grasp a deeper conceptual understanding of the economic concepts i.e. evolving the theory from 2D on paper to a 3D image of knowing.

The enactment of knowledge as mentioned above cannot be fully explained by the theories of constructivism and experiential learning alone and so I began to search for different educational paradigms which would offer a more complete explanation for the findings revealed by this study. The importance of total immersion into the gaming intervention in the form of behavioural, cognitive and emotional buy-in by the students is aptly described by the theory of enactivism, where "cognition, according to enactivism, involves not only rational thinking but all forms of learning, namely emotional, sensual, existential, spiritual and experiential learning" (Van den Berg, 2013, p.199). Enactivists, according to Begg (2000), view learning as a complex activity in which the student and the context become one, where their experiences cannot be separated from the world around them. "Learning must attend ultimately not only to the intellect, but the whole person, and therefore, to *transforming who we are as people"* (Barnacle, 2009, p. 32*). This is a dynamic interaction which opens the* door to a myriad of possibilities for the development of new knowledge, a field which needs deeper investigation and further research.

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