IQA: A Researcher's Qualitative Toolbox to Examine 'How and Why' Students Learn From Economics Games

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Introduction

Over the years, international literature has shown a growing interest in using games as an instructional medium to improve learning in the classroom, as games claim to be an effective means of passing on knowledge and skills to students. Although much has been documented about the potential of games to facilitate engagement, motivation and student-centred learning, there is "little concensus 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 & Aleson-Carbonell, 2012, p. 435).

According to Wideman et al. (2007), major gaps exist with respect to research into the gaming process and the way in which its design elements contribute to effective learning. "This will require new methods and tools for unpacking the complex processes at play in gaming and for investigating the wide range of possible outcomes in the educational process" (Wideman et al., 2007, p. 15). They also highlight the limitations to research which has been undertaken into the pedagogical effectiveness of games, such as: the reliance on feedback from lecturers and the students themselves; and the lack of documentation of the mapping of the cognitive and learning processes employed during the playing of the game. "An understanding of game play and its relationship to the cognitive processes it evokes in users is essential for answering the question of how games succeed or fail, and it plays a critical part in untangling the complex relationships between various game attributes, the learning process, and learning outcomes" (Wideman et al., 2007).

My research focuses on the mapping out of the cognitive and learning processes employed by students during the playing of educational games in the economics classroom in an effort to change the current paradigm of teaching from a passive to an active classroom. The idea of using classroom experiments / games (the term is inter-changeable) to teach economics has been around since 1948 (Holt and McDaniel,1998), but research into the educational use of games in South Africa, to teach economics is minimal, besides the work of van Wyk (2011) and Davis (2009). Many of these games, according to Guest (2012), "are simplified versions of more formal experiments that have been developed as part of a research project" (Guest, 2012, p.1).

Gremmen and Potters (1997) noted that the efficacy of gaming seemed to be supported by subjective indications namely: positive impressions among students and teachers and the outcome of questionnaires. However, they felt that the use of controlled experiments was needed to provide more objective evidence on the efficacy of gaming. By setting up a controlled experiment where one group was exposed to a game and the other was exposed to the traditional lecture method they discovered that the game group learned more about the economic model than the lecture group as shown by the higher test scores.

Since then, further studies have provided evidence that this experimental pedagogy results in higher student achievement in economic courses, better retention of course material, higher student motivation and favourable impression of economics, when compared with traditional chalk and talk pedagogy e.g.

1. Emerson and Taylor's (2004) experiments boosted microeconomics students' scores. They found experiments increased the scores of both females and males, but helped females close the gender gap. They also benefited the weaker students with lower overall grades.
2. Ball, Eckel and Rojas (2006) – improved the overall mark on the final examination. They found the benefit was stronger for females than males, especially for first year students.
3. Tsigaris (2008) indicated that classroom experimental games can have a double dividend for lecturers. The first dividend is higher and more favourable evaluations of the lecturer by students as a result of using classroom games; the second was from improved student performance in exams.
4. Gremmen & van den Brekel's (2013) research focused on motivational effects of classroom experiments on students. They concluded that classroom experiments had a positive and significant effect on student motivation.
5. Nkonyane and van Wyk's (2015) research showed that by introducing in-class simulations into a pre-service the teaching programme resulted in improved academic performance by the teachers and provided an ability to link what they learned with the real world.

Introducing the qualitative approach

As you can see most of the research that has been undertaken into the cognitive (i.e. improved student performance) and motivational benefits of using games have used a quantitative approach. However, not much has been written about the way students learn from games and why (the cognitive and learning processes) – a qualitative approach. My research utilises the interpretivist/ constructivist approach which focuses on understanding, in other words, knowledge is created not discovered by the mind (Andrews, 2012). This approach builds not only on "observable phenomena, but also on descriptions of people's intentions, beliefs, values and reasons, meaning making and self-understanding (Henning, Van Rensburg & Smit, 2004, p.20). This is precept is endorsed by Mackenzie & Knipe (2006) who suggest that knowledge is socially constructed from human experiences – interpretivist/constructivist paradigm.
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Analysis using IQA

Coming from a quantitative research background which was objective, I was looking for a qualitative research design which would provide a transparent, accountable and rigorous process of collecting and analysing data, but also showed the potential causal relationships between the factors identified to give an idea of 'how and why' students learned from games.

I was, therefore, attracted to Interactive Qualitative Analysis (IQA) designed by Northcutt and McCoy (2004), due to its systematic, rigorous and accountable framework as a means to analyse qualitative data (Tabane and Human-Vogel, 2010). With IQA, the researcher takes on the role of facilitator, while the participants generate, analyse and interpret their own data – this is the major difference between IQA and traditional qualitative analysis where the researcher is the sole analyst and data interpreter. As the facilitator in the IQA process, the researcher guides the participants through the process. This is a key means of reducing the postmodern issues of trustworthiness, dependability and confirmability in qualitative research (Tabane and Human-Vogel, 2010).

The IQA protocols, as designed by Northcutt and McCoy (2004), ensure that the researcher has minimal influence over the data created by the participants, as sets of rules govern the research process. This means that each of the participants should have a collective understanding of the phenomena as a result of looking at the causal relationships between the themes (affinities). Collectively they develop a System Influence Diagram (SID), which is a graphic illustration of the phenomena and the inter-relationships between the various themes (affinities). This representation is sufficiently systematic and replicable, so that another researcher would be able to produce a similar outcome.

Underpinning the IQA research method and design is a particular set of beliefs and values based their ontological and epistemological assumptions.

Ontological assumptions

IQA examines the relationship between the researcher and the participants as "IQA presumes that the observer and the observed are dependent" (Northcutt and McCoy 2004, p. 16). This challenges the idea that within most qualitative studies it is the participants who generate the data and only the researcher who is qualified to interpret it (two distinct processes). Using the IQA design, the researcher becomes responsible for facilitating the process within which the constituents generate and analyse (interpret) their own data (a single process).

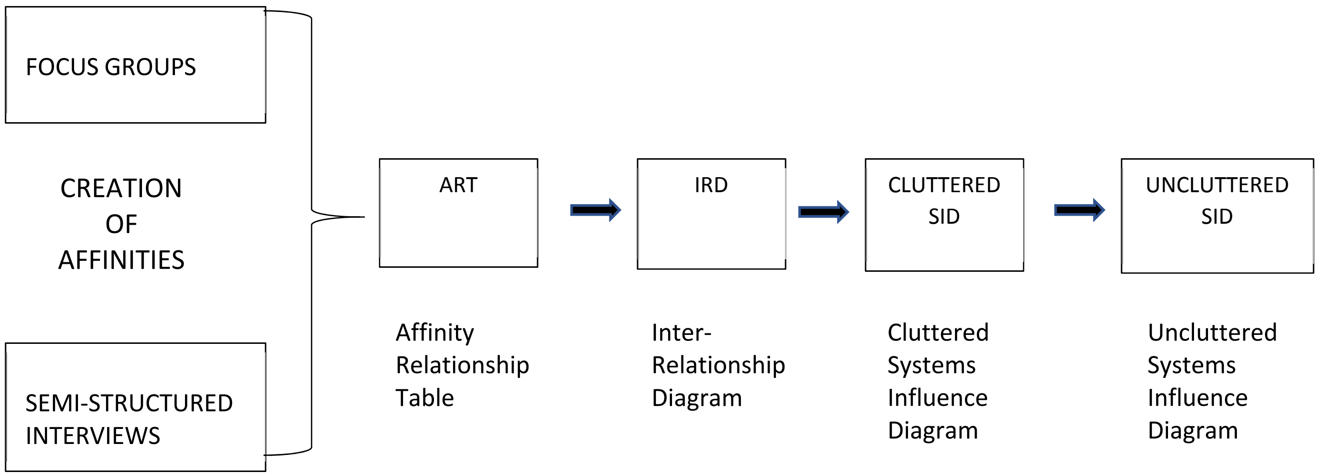
IQA works on the premise that the chosen participants are those who are the closest to the phenomena being researched. Here, the participants' voice is paramount as the reality of the phenomena being investigated (in my particular study – 'how and why' students learn from a gaming intervention) is based in their minds and seen through their eyes. Therefore, "the object of research in IQA is clearly reality in consciousness (the phenomenon), rather than reality itself" (Northcutt and McCoy, 2004, p.16).

Epistemological assumptions

Social constructivism provides IQA's epistemological base, as the premise of the research design is that people know their world through social construction of meaning. The interpretation of the data, through the processes of induction and deduction, arise from a highly contextualised background (the gaming intervention). However, the picture that emerges is decontextualised. This, according to Northcutt and McCoy (2004), is very useful as long as it is grounded in the context. It is, therefore, the researcher's responsibility to provide a thick description of the process which is "public, accessible and accountable" (Northcutt and McCoy, 2004, p.17). In this way IQA encourages the participants to create their own interpretative quilt, building layer upon layer of meaning, until a theory emerges.

This induced theory results in a mindmap of the participants' thought processes and deductions about the particular phenomena and not the researcher's. This conforms to Northcutt and McCoy's (2004) view that the mindmap is, in fact, a theory as it comprises a set of relationships from which hypotheses can be deduced, showing that IQA is "clearly favourable to theory" (Northcutt and McCoy, 2004, p.17).

The IQA process



Focus group and semi-structured interviews

The process of creating the SID begins with the focus group sessions. Here, the participants develop the themes (affinities) through discussion to reach a mutual consensus. This shared understanding is socially constructed through the collective experiences of participants. The data is then further refined through individual semi-structured interviews to obtain richer descriptions of each identified theme (affinity).

With respect to my research, the focus group participants were asked to reflect upon their experiences during the economic gaming intervention and were provided with cards upon which they were instructed to write one word or phrase (per card), which aptly described the ways in which they had learned from the games. It was made clear, from the very beginning, that they needn't worry whether their answers were right or wrong, as I was interested in their honest responses and that there would be no repercussions. No discussion took place at this point, so that they wouldn't be influenced by each other or myself (as the researcher). Each participant had to work in silence until everyone had jotted down their thoughts/ideas. Once they had stopped producing cards, I then instructed them to stick their cards onto the wall. I then read each card out loud and asked for clarification of its meaning from the participants.

As a group, they were then requested to organise the cards into categories which expressed the same thoughts/ideas ie groups of meaning. The categories were then named using a word or phrase which best expressed each group of meaning, referred to in IQA as affinities. At the end of this process, we were left with a list of defined affinities, which formed the basis for the second phase, namely, face-to-face, individual, semi-structured interviews to gain a richer description of the affinities.

Affinity Relationship Table (ART)

The students who participated in the focus group sessions were asked to reflect on the economics gaming intervention and note down words or phrases which described the way in which the intervention helped them learn economics. These words or phrases were then grouped into categories known as affinities. The individual ARTs reflected the causal relationships between the affinities which could be expressed as one of three possibilities:

(i) Either A causes B (recorded as A → B); or
(ii) B causes A (recorded as A ← B); or
(iii) no relationship (recorded as ≠).

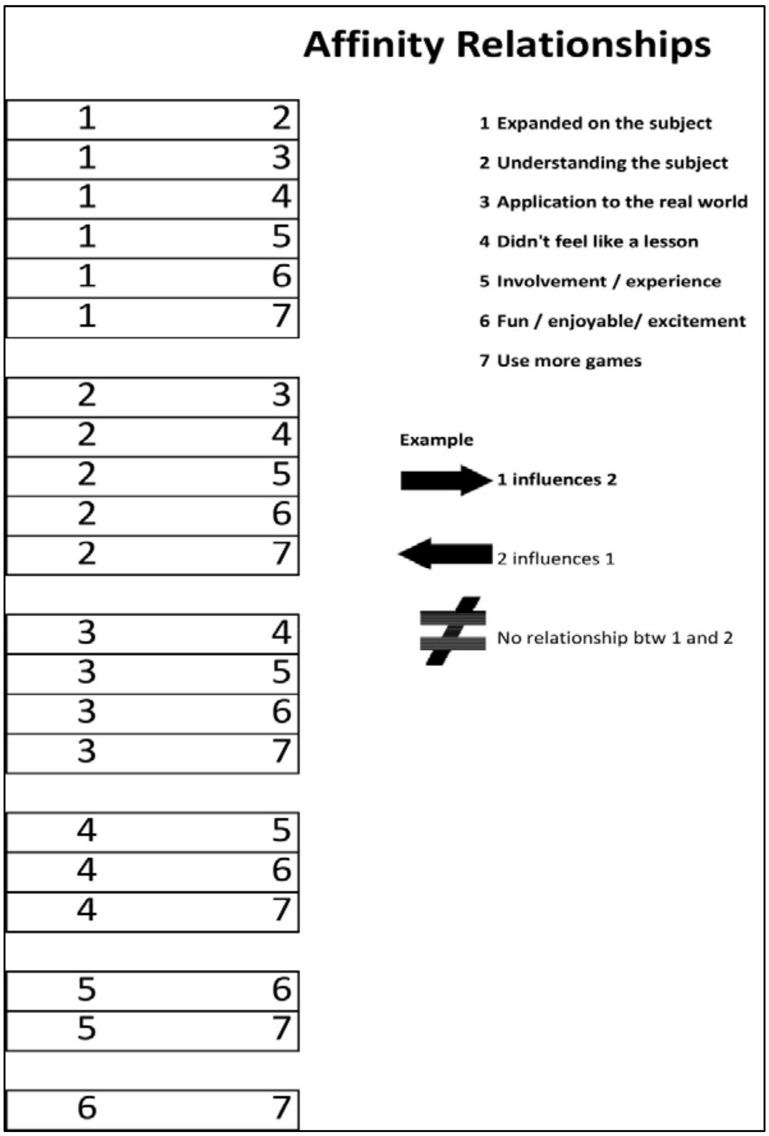


Figure 1: Simple Individual ART

The next course of action was to tally the individual ARTs and create one table ie the Group Composite. For this, I created a spreadsheet which contained the affinity pair and frequency (number of votes received from each of the individual ARTs). These relationships were then sorted according to descending order (from the affinity pair with the highest frequency to that of the lowest).

	Affinity Pair	Frequency
1	2→3	13
2	5→6	12
3	1←7	12
4	5←7	12
5	1→3	11
6	2←7	11
7	3←5	10
8	6←7	10
9	1←2	9
10	1←5	9
11	2←5	9
12	2←6	9
13	3←7	9
14	1←6	8
15	4←6	8
16	4←7	8
17	3←6	7
18	1→6	6
19	4←5	6
20	1→2	5
21	2→4	5

Total Frequency **247**

	Affinity Pair	Frequency
22	2→5	5
23	2→6	5
24	2←4	5
25	1→5	4
26	4→5	4
27	1→4	3
28	2→7	3
29	1←3	3
30	3→5	3
31	3→6	3
32	6→7	3
33	1→7	2
34	3→4	2
35	3→7	2
36	1←4	2
37	4→6	2
38	5→7	2
39	5←6	2
40	2←3	1
41	3←4	1
42	4→7	1

Figure 2: Affinity Frequency

The following step was to determine which of the affinity pairs were to be used in the data analysis to calculate the optimal relationships using the Pareto Principle - “20% of the variables in a system will account for 80% of the total variation in outcomes” (Northcutt and McCoy, 2004, p.156).

	Affinity Pair	Frequency	Cumulative Frequency	Cumulative % (Relation)	Cumulative % (Frequency)	Power
1	2→3	13	13	2.38	5.263157895	2.8832
2	5→6	12	25	4.76	10.12145749	5.3615
3	1←7	12	37	7.14	14.97975709	7.8398
4	5←7	12	49	9.52	19.83805668	10.318
5	1→3	11	60	11.9	24.29149798	12.391
6	2←7	11	71	14.28	28.74493927	14.465
7	3←5	10	81	16.66	32.79352227	16.134
8	6←7	10	91	19.04	36.84210526	17.802
9	1←2	9	100	21.42	40.48582996	19.066
10	1←5	9	109	23.8	44.12955466	20.33
11	2←5	9	118	26.18	47.77327935	21.593
12	2←6	9	127	28.56	51.41700405	22.857
13	3←7	9	136	30.94	55.06072874	24.121
14	1←6	8	144	33.32	58.29959514	24.98
15	4←6	8	152	35.7	61.53846154	25.838
16	4←7	8	160	38.08	64.77732794	26.697
17	3←6	7	167	40.46	67.61133603	27.151
18	1→6	6	173	42.84	70.04048583	27.2
19	4←5	6	179	45.22	72.46963563	27.25
20	1→2	5	184	47.6	74.49392713	26.894
21	2→4	5	189	49.98	76.51821862	26.538
22	2→5	5	194	52.36	78.54251012	26.183
23	2→6	5	199	54.74	80.56680162	25.827
24	2←4	5	204	57.12	82.59109312	25.471
25	1→5	4	208	59.5	84.21052632	24.711
26	4→5	4	212	61.88	85.82995951	23.95
27	1→4	3	215	64.26	87.04453441	22.785
28	2→7	3	218	66.64	88.25910931	21.619
29	1←3	3	221	69.02	89.47368421	20.454
30	3→5	3	224	71.4	90.68825911	19.288
31	3→6	3	227	73.78	91.90283401	18.123
32	6→7	3	230	76.16	93.11740891	16.957
33	1→7	2	232	78.54	93.92712551	15.387
34	3→4	2	234	80.92	94.73684211	13.817
35	3→7	2	236	83.3	95.5465587	12.247
36	1←4	2	238	85.68	96.3562753	10.676
37	4→6	2	240	88.06	97.1659919	9.106
38	5→7	2	242	90.44	97.9757085	7.5357
39	5←6	2	244	92.82	98.7854251	5.9654
40	2←3	1	245	95.2	99.1902834	3.9903
41	3←4	1	246	97.58	99.5951417	2.0151
42	4→7	1	247	99.96	100	0.04

Figure 3: Affinity Optimal Relationship Table

- Cumulative Frequency: Each entry is the frequency of the votes cast for an affinity pair added to the next
.
- Cumulative Percent (Relational) is the cumulative percentage based on the total number of possible relationships. In this case 42; that is each relationship represents 1/42 or approximately 2.38% of the total possible number. The cumulative percentage is one of the two factors used to calculate the Power index.

- Cumulative Percent (Frequency) is the cumulative percentage based on the number of votes (247). Each entry is the percentage of votes cast for an affinity pair added to the previous total. Cumulative percentage (Frequency) is the second factor that is used to calculate the Power Index.

- Power is an index of the degree of optimization of system and is simply the difference between Cumulative Percent (Frequency) and Cumulative Percent (Relational) (Northcutt and McCoy, 2004, p.160).

According to the Pareto Protocol, these last two columns are crucial in deciding which relationships should be included in the IRD. The MinMax Criterion is used to determine the cut-off point for those affinity pairs. In order to do this, the affinity pairs are displayed in decreasing order of frequency, the question now becomes one of where to set a cut-off point. This involves a trade-off between the maximum variation in the system (cumulative percent based on frequency) while minimizing the number of relationships (cumulative percent based on relations).

Accounting for maximum variance: As can be seen from the table very few of the affinity pair relationships account for most of the variance, which is consistent with the Pareto principle. The first 10 relationships (23.8% of the total) accounted for 44.12% of variation and the first 19 (45.22%) accounted for 72.46% of the variation. The 'optimal' number will be reached when the power value is at its maximum. As shown above in Figure 3, this is indicated when the Power reaches a value of 27.2496 which correlates to 19 paired relationships, accounting for 72.46% of the variation (the cut-off point is highlighted in red).

Inter-relationship Diagram (IRD)

The next level of analysis involved the creation of an Inter-Relationship Diagram (IRD) which visually depicted the optimal number of relationships. By determining the causal relationships between the affinities, I could then identify whether they were drivers or outcomes (where drivers 'caused' a result ie an outcome; but, the outcome had no effect on the driver). These relationships are depicted by placing arrows into an IRD table, where the direction of the arrow indicates the influence. There are only two directions in which the arrows can point either to the left or up and each relationship is recorded twice (via column and row).

If an arrow points upwards it is referred to as 'out', whereas, an arrow that points to the left is known as an 'in'. These ins and outs are then counted per row and entered into the respective columns.

To determine whether an affinity is a driver or outcome, a delta (Δ) value is calculated by subtracting the number of ins from outs: Δ= Out – In (for each affinity), where a positive Δ value indicates a driver and a negative Δ value, an outcome.

		1	2	3	4	5	6	7	out	in	Δ
Use more games	7	↑	↑	↑	↑	↑	↑		6	0	6
Involvement/ Experience	5	↑	↑	↑	↑		↑	←	5	1	4
Fun/ Enjoyable/ Excitement	6	↑	↑	↑	↑	←		←	4	2	2
Understanding the subject	2	↑		↑		←	←	←	2	3	-1
Expanded on the subject	1		←	↑		←	←	←	1	4	-3
Didn't feel like a lesson	4					←	←	←	0	3	-3
Application to the real world	3	←	←			←	←	←	0	5	-5

Figure 4: Determining drivers and outcomes

These values are then sorted in descending order to determine their position within the system (Northcutt and McCoy, 2004).

Within the positive deltas, there are primary and secondary drivers. The former, the primary driver, only possesses outs and no ins. The secondary drivers comprise ins and outs, but still have positive deltas.

A primary driver is an affinity which directly affects all the other affinities in the system, but is not affected by them in return. Whereas, a secondary driver which still has a positive delta value, has a relative effect on the other affinities.

The same distinction applies to the outcomes, though these are depicted by negative deltas ie the number of ins are greater than the outs.

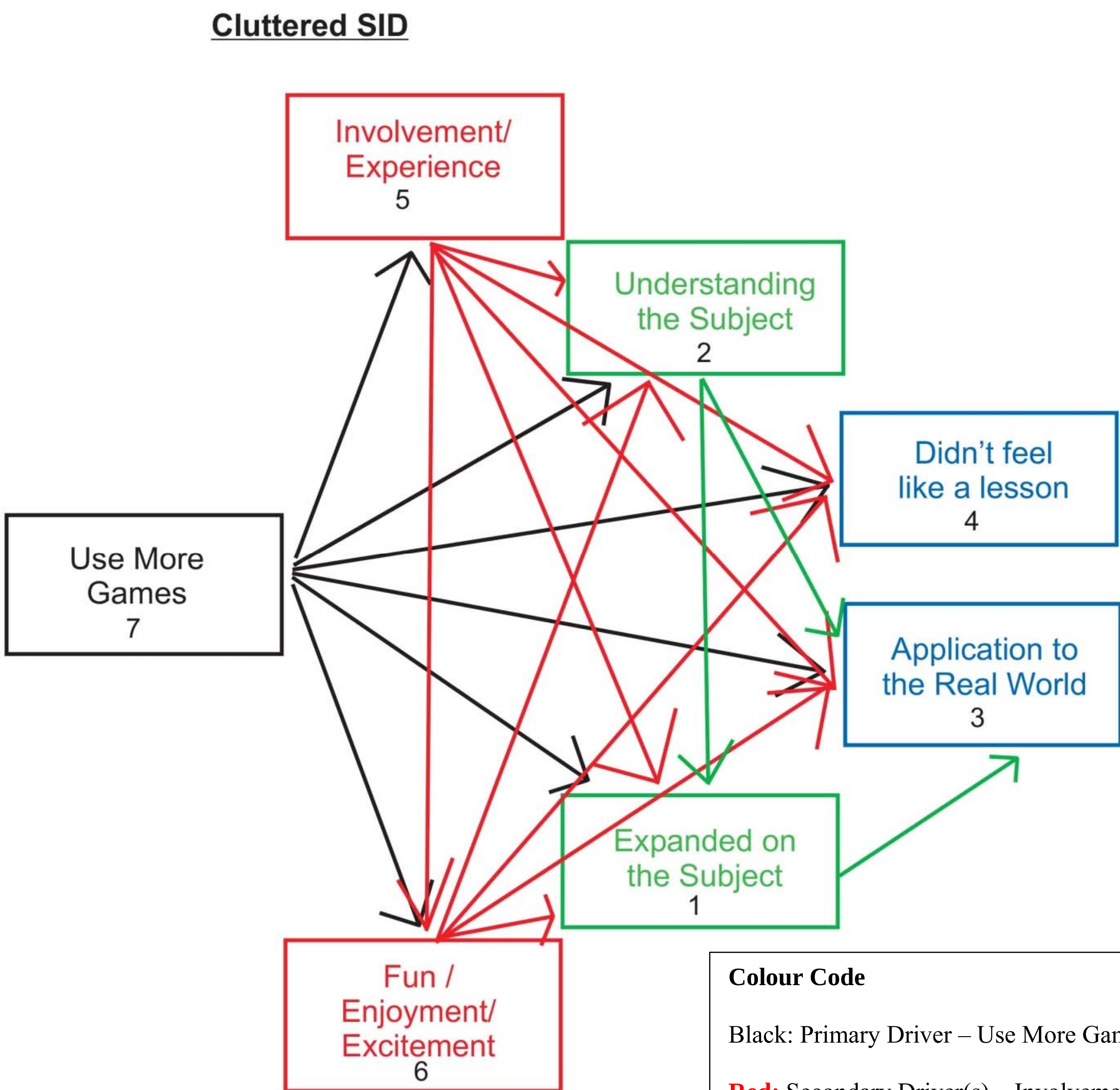
A primary outcome, however, has no outs and the largest negative delta value. This means that the primary outcome is influenced by most of the affinities, but has no effect on them. The secondary outcomes, also possessing negative delta values, are affected by the other affinities, but this is relative ie depending on the delta value, where the ins are still greater than the outs.

A pivot occurs when the number of ins equals the number of outs ie there is no causal relationship between the affinities and the delta value is 0.

The System Influence Diagram (SID)

The main objective of IQA is to provide a visual representation of the causal relationships between the affinities of the system and this is realised in the form of a System Influence Diagram (SID), where the information is taken from the IRD.

Having ranked the deltas in descending order and identified the drivers and outcomes, the next step is to create a visual diagram. As the SID represents the entire system of relationships, this is initially depicted in the form of a Cluttered SID, where every relationship is indicated. The connections are in the form of arrows pointing in the direction of the relationship (as represented in the IRD). This is referred to as a Cluttered SID, as all the links are depicted at once – this is a saturated system according to Northcutt and McCoy (2004). However, while the diagram is rich in data it remains difficult to interpret and draw conclusions.



Colour Code

Black: Primary Driver – Use More Games (7);

Red: Secondary Driver(s) – Involvement/ Experience (5); Fun/ Enjoyment/ Excitement (6)

Green: Secondary Outcome(s) – Understanding the Subject (2); Expanded on the Subject(1)

Blue: Primary Outcome(s) – Didn't Feel Like a Lesson (4); Application to the Real World (3)

Figure 5: Cluttered SID

Now the process of refining the SID begins by removing redundant links – these are "links between two affinities in which, even if removed, a path from the driver to the outcome can be achieved through an intermediary affinity. Redundant links can be thought of as the "paths of least resistance"" (Northcutt and McCoy, 2004, p.178).

Beginning with the affinity with the highest delta (usually the primary driver), one then examines its route to the lowest delta. If, the direct route between the two deltas can be replaced by an alternate route, then the former (the direct route) is removed from the diagram. This process is repeated with each of the deltas until the least number of links remain within the system. The result is an Uncluttered SID which is a mindmap of the system that maintains the "quintessential constructs of the phenomenon" (Bargate 2012, p.71).

Uncluttered SID

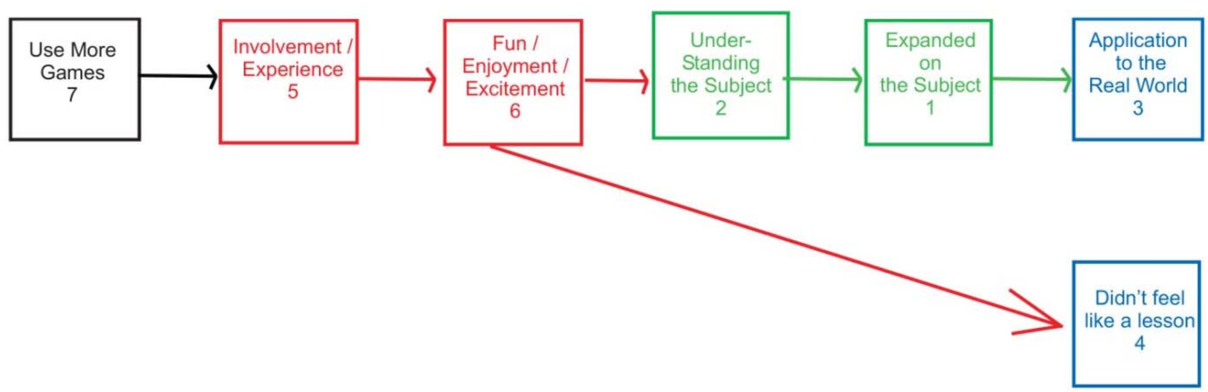


Figure 6: Uncluttered SID

Interpretation of the SID

The investigation involved first-year economics students at DUT who were introduced to a gaming intervention to discover 'how and why' students learn from games. From the class of 120, 24 students were randomly chosen to participate in the IQA process. Of these only 15 accepted the invitation to participate and these are the results. (According to IQA a sample size of between 12 and 20 is sufficient.)

'Use More Games' emerged as the Primary Driver for how the students learned from the economic 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 internalizing 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. This vibrancy and interactivity resulted in the 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 greater understanding of the subject. The internalisation and assimilation of knowledge gave the students the confidence to interpret and explain the economic concepts in their own words, as the concepts now had meaning and purpose. By expanding on the subject, the students were placed into a context where they could see the theory in action which brought meaning and substance to otherwise abstract concepts.

The first outcome of the gaming intervention was that students were now able to relate economic concepts to the Real World ie 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 outcome, namely, 'Didn't Feel Like a Lesson'. Here, the emphasis was on the disruption of traditional lecture format caused by the introduction of the gaming intervention. This brought about a learning environment in which the students felt freed of traditional classroom constraints where they were able to interact with each other; personalise their learning; and, naturally retain what they had learned.

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

Conclusion

IQA provides a structured manner to do qualitative research where one wants to build a model showing not only the factors that are revealed by the theory in richer detail, but also in establishing causal relationships between factors.

However, IQA is a lengthy process with the focus groups needing nearly three hours per session to complete their discussions. In addition, the group composite may be an over-simplification when it comes to showing the inter-relationships between variables especially when dealing with such complex issues as learning.

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