Game Design and Teaching for Understanding

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Abstract: This paper will look at how game design can be related to Learning Outcomes (LO) based on Blooms Taxonomy, and to the Teaching for Understanding (TfU) framework. I argue that traditional assessments often offer learners a closed pathway to solutions by delimiting the problem by title and required sources whereas requiring learners to design a game on a topic requires a research process which explores a wider range of possibilities. Game design as an assessment requires students to cross the bridge from narrative descriptions of problems to expressing them in the procedural rhetoric of game mechanics. Whereas narrative explanations always include an element of ambiguity, game mechanics require explicit rules. Based on actual cases in teaching, I will lay out how the different elements of a game design assessment fits with both learning outcomes and Teaching for Understanding. As Teaching for Understanding is focussed on process initiated by generative questions rather than outcomes, it is a better framework for developing the skills required to explore contemporary complex and 'wicked' systematic and systemic problems.

Keywords: Pedagogy, Game design, Assessment, Learning outcomes

1. Essay v Game

I began experimenting with game design based assessments around 2006 due to the limits of essay-based assessments in a humanities field. It was clear that many students were meeting the learning outcomes by producing papers which did indeed embody the tropes of the field but their work did not evidence of a mind at work indicating understanding of the problems being explored. This is more problematic when Large Language Models can generate text which models very closely the sort of writing which academics regard highly.

In essay-based assessments the title often closes off the question by setting limits and pre-determining the main axis of the argument. This may be further circumscribed by providing a set reading list and having delivered lectures on the topic. Many students come to university from secondary systems which reward answers based on 5 to 7 paragraph essays in which each paragraph consists of three facts and a date, and it is all too easy for them to slide through university and produce adequate answers by replicating this model.

Playing, or designing a game, demands a more open approach which weighs a wider range of possibilities and force learners to make decisions about possible alternative outcomes and their likelihood.

> *"This is to engage in counterfactual history – to ask not just what happened, not just why and how it happened, but also what else did not happen, and might have done, and what might have been the consequences of these alternative narrative causalities? To re-quote Patrick Rael "Counterfactual history is real history … to engage in counterfactual history is actually to engage historical thinking, historical methods and skills … Counterfactual history is serious history …" (Suckling, 2024)*

Even the simplistic designs of wargames (and games in general) prior to about 1976 offered a deeper challenge to learners than simply reproducing disciplinary tropes in an essay. Thus, in a game like Napoleon at Waterloo which offered learners complete control of all the elements of the action and the ability to finely calculate the likely outcomes of any combat in advance still required them to do more thinking than summarising the content of the accepted narratives.

But that is to disregard key concerns in the minds of the leaders in both cases. On the morning of Waterloo, and for most of the day, Napoleon had no idea where Grouchy was, if he would arrive and or if he would prevent the Prussians from appearing. At Gettysburg on the first day, Lee had no idea where most of his army was, and through the whole battle had no idea where Stuart's cavalry was or if they might appear.

In conventional assessments, The Imperial Guard, Picketts Division, Hamlet and Romeo march resolutely towards their inevitable doom. In Game Based, and Game design based assessments, Learners must begin not at the end of the journey, but at the beginning, ripe with possibilities for alternative pathways. If we are to understand and learn from the humanities, we need to consider how the actors in our stories saw their situation and what alternatives they considered possible, and why they chose as they did

Additionally, game design-based assessments require learners to decompose problem into their components, identify relationships between parts of the problem, and quantify those relationships so that they can be expressed as game mechanics. These are important skills required for analysing real world problems. These

skills are particularly important for building any digital tool where the ability to convert narrative description to digital processes is an essential, and rarely taught skill.

We now know that our world is not a simple clockwork thing, where certain clear actions will produce predictable outcomes. From Bacon and Descartes until WWII, objective science based on clockwork models working within disciplinary boundaries led to huge advances in human knowledge. Since WWII we have come to confront a range of problems which do not admit of solutions by simply building a better clock. The most important real-world problems which we now face are complex rather than complicated.

Complicated problems are mainly confined to a single disciplinary field, may involve many moving parts but can be resolved with a simple, mechanical, and predictable methods. They can be reduced to pieces of knowledge which, when fitted together in the correct way, lead to a solution. Complex problems go beyond the clockwork model of complicated problems and involve systems which are often do not have clear boundaries and are sensitive to small variations in initial conditions. Complex problems manifest emergent behaviours and may exhibit sudden state changes. The relations between elements of complex problems are often non-linear.

Complex systems theories were first applied to understanding problems in ecology and climate (Meadows and Club of Rome, 1972) but are now seen as vital in understanding a range of problems.

2. Narrative Ambiguity, Procedural Rhetoric and Explicit Rules

Notwithstanding the difficulty involved in modelling complex problems in a game design assessment, it is possible to leading students through the process of deconstructing the narrative of a complex problem and exploring how one can grasp how some of the elements interact with each other. Over time, I have iterated towards a course sequence for my game design courses which helps to move from ambiguous narrative to explicit rules.

- Choose Topic
- Identify a lead character
- Identify 3-5 important actors
- Identify important processes linking characters and their journey through the game world
- For each of these, state a key step or event in 1 sentence. (Matrix Games)
- For this step, identify 3 things which contribute to a positive outcome
- For this step, identify 3 things which contribute to a negative outcome

Students are allowed to suggest their own topics for their game designs, but a list of possibilities is provided. Students are required to produce concepts for digital or analogue games for two different problems in semester long courses. Students, supported by readings on worldbuilding in games, describe the setting or world in which their topic is located. Students are then asked to identify a key character, a 'hero' and 3-5 important actors present in this game world. Identifying the processes at play in the problem setting is supported by readings on the 'Heroes Journey' and Vladimir Propps formalist theories of folklore, although these do not always fit well with this step of the process as we move from a narrative focus to a process one. By now the students are developing a systems model of the actors in the system and the interactions between them. Students are presented with an abstract model of a systems diagram and asked to name the objects and flows in it. (see Figure 1)

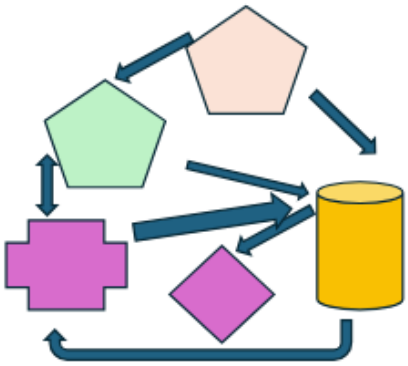

Figure 1: Simple systems model showing problems elements and flows between them

At this point in the semester, we being to move towards explicitly describing processes or events in the game world. Students are asked to express action in the world in the form of matrix game statements. Matrix games develop from Delphi Method Simulations by requiring participants to state what will happen in a specific format: “My Character will sneak into the Temple of Elemental Evil. They will succeed because they will do it at night, because it is dark and some of the guards have poor vision. They may fail because there are traps, and some of the guards are dark elves with night vision.”

The next step is to begin putting numbers on these interactions. This is a significant step, it can be considered a threshold concept in game design-based assessments.((Meyer, Land and Baillie, 2010) Probabilities on 3 normal 6-sided dice (which generate a normal distribution curve) are explained, as is the way in what character attributes in tabletop roleplaying games relate to real world abilities using GURPS (Generic Universal Role Play System) as an example. To explain this, I describe my own attributes and skills in terms of the GURPS system values – I have below average dexterity and skill, but above average intelligence. My research skill is excellent, but my academic writing skill would not be as high. Sherman Kent’s work on language of estimative probability is also introduced to inform this step. Kent surveyed NATO officers to determine what they meant by the language they used to express the likelihood of future events, and from this produced a set of recommended terms for use in intelligence estimates (see Table 1) . This method is used in reverse to convert results from clinic drug trials into plain language on leaflets provided to uses of pharmaceuticals (Kent, 2025).

Table 1: Language of estimative probability

Kent's "words of estimative probability"		
Certain	100%	Give or take 0%
The general area of possibility		
Almost certain	93%	Give or take about 6%
Probable	75%	Give or take about 12%
Chances about even	50%	Give or take about 10%
Probably not	30%	Give or take about 10%
Almost certainly not	7%	Give or take about 5%
Impossible	0	Give or take 0%

By this point, students will have made significant progress from an initial narrative description of the problem on which their game design assessment is based to at least a partial quantitative model of the situation. Students are not expected to produce a comprehensive stock and flow diagram for a system they are exploring since they are required to produce outline concepts for two games on different topics during the semester.

I will now look at how this fits with assessments under LO and TfU in specific cases.

3. Learning Outcomes

While having Learning Outcomes is better than not having any form of common vocabulary to describe courses, they suffer from severe limits. LO based on Blooms taxonomy were originally defined in 1956 and therefore are firmly located in a period dominated by behaviourist concepts of education. Even though Blooms Cognitive Taxonomy was improved by the revision of Anderson and Kraithwohl in 2001 (Anderson and Krathwohl, 2001), the framework predates and does not reflect the emergence of constructivism or cognitive theories of pedagogy

It is possible to frame LO to reflect constructivist pedagogies, but this is not a comfortable fit. In particular, LO do not address the process of building understanding over the sequence of a course. LO approaches do not naturally accommodate what we now know about the internal process of cognition and how learners

incorporate new knowledge into their internal 'map's of knowledge. While constructivist theories of learning are by no means complete, they have moved on significantly from when LO were conceived. Criticism of LO is thin recently, because such critiques have been swamped by the bureaucratic stranglehold LO enjoy, but well-founded critiques do exist. For example, as early as 1971, Sockett and Pring both argue that Blooms taxonomy was not strictly speaking a taxonomy at all and imposed an impossibly precise veneer over complex concepts. Even at the lowest level, of remembering, in the case of a traffic accident, our memory of the 'facts' are affected and filtered by a reasoning process based on our prior ideas of how such an event unfolds. (Pring, 1971). Pring argues that

> *"To say that one knows that something is the case, namely, that Henry VIII had six wives or that gases expand when heated, means that one understands not only the concepts employed but also under what sort of conditions these statements might be considered true or false. That is, knowledge entails both comprehension and application – it is not possible to aim at knowledge and then at the understanding of this knowledge and then at applying it. To know that something is the case entails understanding what it means to say that something is the case and this in turn entails being able to apply this knowledge to particular situations."(Pring, 1971)*

Pring in his conclusion argues that Bloom failed to investigate what it means to know something, making his classification inadequate for its purpose. Since behaviourism dominated theories about learning when the taxonomy was developed, it is hardly surprising that it did not take account of how we learn. Working within the system of Learning Outcomes based on a conceptually limited base is therefore difficult.

4. Teaching for Understanding

Teaching for Understanding (TfU) traces its intellectual lineage back to the progressive educational ideas of John Dewey who emphasized learning through experience and reflection rather than rote memorization. Dewey's philosophy laid the groundwork for pedagogies focused on active, student-centred learning (Dewey, 1938). It is also informed by constructivist theories of learning. Influenced by Jean Piaget and Lev Vygotsky, TfU emphasizes that learners construct knowledge actively through interaction with their environment and social contexts (Piaget and Cook, 1952,) (Vygotsky, 1978).

The TfU framework was developed in the late 1980s and 1990s by researchers at the Harvard Graduate School of Education. It responded to concerns that students were learning facts but failing to apply knowledge in meaningful ways. Howard Gardner, known for the theory of multiple intelligences; contributed ideas on personalized and meaningful learning while David Perkins advocated for understanding as the ability to think and act flexibly with what one knows. This leads to the idea central to TfU of 'performances of understanding' which lead to achieving understanding goals (Perkins, 1992) (Gardner, 1995).

The core elements of the TfU Framework are

Generative questions: Open-ended, thought-provoking inquiries that spark curiosity and guide learners toward exploring central ideas and developing deeper understanding.

Understanding Goals: Clear expression of what students should understand.

Performances of Understanding: Activities that require students to apply knowledge in new and increasingly challenging situations.

Implicit in the framework are the ideas of ongoing Assessment through performances of understanding and the provision of continuous feedback to guide and deepen student understanding. Also important is a learning environment which encourages curiosity, collaboration, and risk-taking in learning (Blythe, 1997).

TfU emerged as reaction to outcomes-based approaches and "teaching to the test", which is a natural consequence of the superficial use of LO. TfU provided a pedagogical response that aligned with constructivist theories(Wiske, 1997).

A key feature of the TfU framework is the planning grid which shows clearly the relationship between generative questions, throughlines, performances of understanding and understanding goals. In this version (Table 2) extra rows are included to allow for planning specific activities across a 12 week semester.

Table 2: Teaching for Understanding Organiser

	Generative Question		
Student entry point - prior knowledge? Relevant skills?	**Throughline**	**Throughline**	**Throughline**
Performance of Understanding 1 'Messing around"			
Performance of Understanding 2 Guided Inquiry			
Performance of Understanding 3 Mastery			
	Understanding Goal	Understanding Goal	Understanding Goal

5. Case: Wargame Design

The oldest case was in a second year undergraduate survey course on "War, State and Society, 1405-1920". In this course a conventional mid term essay was replaced by a group task in which students designed a one page wargame on a battle from the 'Age of Battles'.

The learning outcomes for the module were

1. Demonstrate an accurate knowledge of the major developments in military history since 1450 by deploying this information in examination answers and coursework.
2. Demonstrate a knowledge of the central historiographical debates and methodologies of military history and how they to the relevant historical issues, concepts, dates, figures, and evidence by deploying these concepts and methods in examination answers and coursework.
3. Demonstrate an ability to engage in online, reflective discussion of issues relating to the course
4. Locate, analyse and synthesise a body of primary and secondary source material appropriate to the field.
5. Acquire the necessary skills and abilities associated with studying the context and conduct of warfare.
6. Acquire and apply a range of skills associated with research, writing, analysis, argument, evaluation and historiography to participate in individual and group work associated with active analytic military history.
7. Acquire and demonstrate the necessary skills associated with writing clear and comprehensive examination answers.

There is no reference to game design in those, given that no one else was using game design as assessment, no 6 was inserted in which 'active analytic military history' clearly refers to wargame design in language which wargame designers would recognise but which would not attract the notice of curriculum rules committees.

Students were introduced to simple or entry level hex and counter wargames, specifically Napoleon at Waterloo (SPI, date). The mid-term was only 20% of the total course mark. Setting it as a group exercise reduced the risk an individual failing to grasp some element of what was required. Discussion threads for each group were created in the LMS, and their activity in those discussions was monitored. Technical feedback was

provided and, where needed, groups which were falling behind were engaged with. To provide clarity on expectations, the comparison with a conventional essay was laid out for the students. All of these were done to reduce the risk involved in introducing a novel assessment.

The initial version of this table (Table 3) only included indications of later grades whereas in this updated version specific sentences from the grade descriptors from the universities general rubric for all subjects are added for clarity.

Table 3: Elements of essay, wargame design exercise and grading guidance

Bloom's Taxonomy (revised)	Essay	Wargame Design	Grade
CREATING	Historical debates, Hist Understanding,	Design notes which reflect on the game	A. A highly developed capacity for original, creative and logical thinking
EVALUATING		Games rules in total, Special rules, victory conditions	B+/A well-developed capacity to analyse issues, organise material, present arguments clearly and cogently
Analysis	Linkages, relationships	Game rules – cases (move, fire etc)	C average critical awareness and analytical qualities
Application		choose scales and design counters, map	C some effort to engage, but only a basic understanding of the topic portrayed
Comprehension	Significant facts?	tables of organisation	D descriptive rather than argumentative or analytical answer presented
Knowledge	Facts	Order of Battle, Map	D basic grasp of subject matter but limited focus on question asked

The assignment proved to be uncontroversial and quite successful. From 2006 until 2012 student groups produced games which were usually comprehensive and accurate, within the limits of historical sources, for their cases. Many groups identified critical elements of the battles such as terrain features or leadership failures. Most groups were able to justify their choice of special rules or victory conditions. Games were playable and balanced (again, within historical constraints). Occasionally, attempts to devise innovative mechanics to resolve combat were not a success but this was often due to limited numeracy among humanities students and in any event, credit was given for making a genuine attempt to explore the representation of kinetic effects in the design. While the assignment had a substantial visual element, no marks were given for graphic quality since this was outside the capability of the students.

For the purposes of an example for this paper, I retrofitted that older assignment with the elements of the TfU framework – a generative question, throughlines, understanding goals and performances of understanding (Table 4). The main feature here is that the three performances of understanding align with the process suggested to the students for the original assessment, and groups which followed those steps were generally more successful than those which lacked a structured process. The third throughline and understanding goal on the value of games was not an explicit element of the original assessment but it certainly came up in discussions during the course and I would now include it explicitly. The three understanding goals could be presented as learning outcomes in a module description

Table 4: Wargame design exercise outline in Teaching for Understanding organiser

	Generative Question: How can designing a wargame help us understand the impact of, technology on the development of operational art in historical battles from 1450 to 1815?		
Student entry point - prior knowledge? Relevant skills?	Throughline: How did military strategies and technologies shape the outcomes of early modern battles?	Throughline: In what ways did geography and logistics influence historical warfare?	Throughline: How can games be used as tools to represent and explore complex historical events?
Performance of Understanding 1 'Messing around"	Students study a specific battle to identify troop types, units and terrain.		

Performance of Understanding 2 Guided Inquiry	Students explore their chosen battle to know about army organisation, how combat plays out and how terrain and leadership affect the battle		
Performance of Understanding 3 Mastery	Students create integrated rules and mechanics for a simple wargame that reflects the historical dynamics of their chosen battle, justifying their design choices with historical evidence.		
	Students will understand the tactical principles and key technologies that defined warfare in a chosen battle from 1450–1815.	Students will understand how terrain, supply lines, and troop movements impacted operational decisions.	Students will understand how historical simulations and games can model—but also simplify—real historical complexities.

6. Case: General Game Design Assessments

Over the past decade in the Dept of Digital Humanities we have explored several areas of game related research and teaching, including narrative driven games and the possible applicability of 'auteur' theory to the role of lead game designers. Since our teaching in strongly research led (and our research is often informed by our teaching), we have offered a range of game design based courses. The structure of our current offering follows the game design sequence outlined above (see section 1.3, key steps of which are included in this TfU chart)

Table 5: General game design assessment presented in Teaching for Understanding organiser

	Generative Question: How can game design be used to deepen understanding, inspire engagement, and provoke meaningful learning on TOPIC X		
Student entry point - prior knowledge? Relevant skills?	Throughline: Design shapes experience – Understanding how mechanics, narrative, and user interaction influence how players learn and what they take away on TOPIC X.	Throughline: Games are powerful learning environments – Exploring how games can simulate systems, encourage exploration, and support knowledge construction on TOPIC X.	Throughline: Games reflect and challenge values – Examining how games carry assumptions, represent (or misrepresent) perspectives, and offer space for critical reflection on TOPIC X.
Performance of Understanding 1 'Messing around"	Students select a topic and identify key elements of that topics - actors/characters, world/setting (Choose Topic, Identify a lead character , Identify 3-5 important actors, Identify important processes linking characters and their journey through the gameworld.)		
Performance of Understanding 2 Guided Inquiry	Students map the relationships between game elements and quantify those relations (For each of these, state a key step or event in 1 sentence, identify 3 things which contribute to a positive outcome, identify 3 things which contribute to a negative outcome.)		
Performance of Understanding 3 Mastery	Students have a near playable (B/C) or finished (A+) game on their topic and can reflect on how it explores the problem under study. Students can reflect on their learning from the process.		
	Understanding Goal: (Design shapes experience) Students will apply principles of game design to create learning experiences that align game mechanics learning on the chosen topic	Understanding Goal: ((Games are powerful learning environments) Students will understand how different types of games can facilitate various kinds of learning—cognitive, emotional, social—and evaluate their educational potential.	Understanding Goal: (Games reflect and challenge values) Students will analyse how games represent ideas, cultures, and systems, and design games that either reinforce or critically question existing narratives.

In this general framework(Table 5), activities related to each throughline and understanding goal will not always be evenly distributed across the duration of the module. Work related to throughlines 1 and 2 will

mainly arise in the first two thirds of the course. Work related to the third throughline-understanding goal pair (Students will analyse how games represent ideas, cultures, and systems, and design games that either reinforce or critically question existing narratives.) will mainly appear in the final part of the course. Throughout weekly feedback is provided in the discussion forums and by video. For Group work, students are introduced to current guidelines on crediting contributions and expected to meet these. This progression not only fits with the Community of Inquiry model but also with the Structure of Observed Learning Outcomes model (SOLO) offered by Bigg and Collis in 1982(Biggs and Collis, 1982). SOLO represents a significant conceptual advance on Blooms taxonomy, showing how learners make richer and deeper connections at higher levels in a way which Bloom, even in its revised form, does not.

While the conventional TfU structure only identifies three assessed performances of understanding, I break the work into weekly sections with student answers posted in course discussion forums. This allows monitoring, especially in the early stages of student progress as the early stages tend of be fragmentary and exploratory. The later parts tend to range more widely, integrating ideas and advancing towards a critical resolution of the topic. Each weeks work, as well as the overall course arc, tends to follow the Community of Inquiry model (Trigger-Exploration-Integration-Resolution) which is similar to the Interaction Activity Model. (Garrison et al, 1999; Gunawardena et al 1997) Early weeks of the course include lectures on elements of contemporary games across genres – board, collectible card, deckbuilding, tabletop rpg – since students lack broad knowledge of the range of game type and possible mechanics.

When students have chosen topics for their game designs (and students, especially undergraduates, often have difficulty in choosing topics.) they can then be prompted to suggest their specific generative question and throughlines to help frame their specific game topic. Thus games on climate resilience for example may engage with issues like local and global action, or the just transition in their generative questions or throughlines.

7. Conclusions

Assessment across the Humanities and social sciences is still dominated by essay answers or similar. Academic planning is dominated by the learning outcomes rooted in Blooms taxonomy. The bureaucratic stranglehold enjoyed by learning outcomes based approaches, manifested in Europe by being explicitly mandated in the European Higher Education area because of the Bolonga process, marginalises models which better reflect of growing understanding of cognitive process and the constructivist paradigms like Community of Inquiry, Interaction Activity Model, Structured of Observed Learning Outcomes and above all Teaching for Understanding. Advocates of game based and game design based assessments often face issues in linking their teaching to assessment guidelines. Here I have looked in detail at how this was resolved in my teaching. In practice, mapping game design assessments to LO was mainly done to comply with institutional rules but these assessments were framed in the TfU framework. Linking the sequence of activities in game and game design based learning to contemporary pedagogical theories facilitates explaining these to external examiners, as well as to students in ways which foster their metacognitive development

Ethics Declaration: No ethical approval was required for this paper

AI Declaration: LLMS were used for initial generation of some elements in Tables 4 and 5; necessary edits were applied to make these fit the models in these tables

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