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Scaffolding Content and Context:

A revision of Gregory Bateson's learning theory through a micro-level analysis of how learning takes place in the computer game *StarCraft 2*.

Abstract

The aim of this article is to revise and expand Gregory Bateson's theory of learning to demonstrate how scaffolding content and context takes place in computer games. The presented revision rest on a micro-level analysis of how learning takes place in the computer game *StarCraft 2* a successful triple A (mid-sized to major publisher with high development budgets) computer game. The revision of Gregory Bateson's learning theory will draw on the following concepts: difference, identity, (self)referentiality, and expansion. The result from the analysis will demonstrate how scaffolding content and incremental construction of contexts works in and outside the realm of computer games.

Keywords: learning, Gregory Bateson, scaffolding, content, context, StarCraft 2

1 Introduction

This article is interested in learning. Especially learning in computer games. Often when learning and computer games are mentioned in the same sentence the writing or conversion is preoccupied with one of following three perspectives, broadly speaking of course.

The first perspective is concerned with how computer games can teach different subject matters in the educational system ranging from preschool to university courses. This perspective usually goes under the header game-based learning or serious games (Salen, 2008; de Freitas & Maharg, 2011; Davidson, 2008; Schrier, 2014, Schrier, 2016; Yee, 2014). It is a highly disparate field that when viewed from a distance is driven by an interest of combining a pre-established learning content with computer games as delivery system for that content.

The second perspective investigates what kind of skills is learned when solving complex tasks in computer games. It is preoccupied with competences derived from the activity of playing computer games (Barab, Zuiker, Warren, Hickey, Ingram-Goble, Kwon, Kouper, & Herring, 2007; Felicia, 2014).

From a knowledge (Serres, 2009) standpoint is the difference between these two perspectives essentially; “knowing that and knowing how – between declarative knowledge and procedural knowledge or being able to explain something and being able to actually do it [and it] is fundamental to education as we know it.” (Shaffer, 2006 p. 91-92). Keith Devlin (2011) echoes similar distinctions when he outlines the difference between solving math assignments and learning mathematical thinking. The difference is between learning “basic skills” or “thinking” (p.3) math. Ian Bogost (2007) as he himself states run the risk of oversimplification when he places these perspectives in either the behaviourist or constructionist educational camp. “The “traditional” classroom relies on behaviourist learning strategies. Students practice within question/answer frames that reinforce knowledge of a subject matter. Students respond (in speech or writing, for example) and receive immediate feedback in the form of positive or negative reinforcement [as opposed to the constructivist perspective that empathise learning of] abstract principles that service general problem-solving skills and learning values” (pp. 235-239). Positions in between try to fuse content and problem-solving skills focusing on what players actually do when they play (Squire, 2006).

The third perspective on learning and computer games focuses on how the game teaches the player to play the game as James Paul Gee (2003, 2005) explains. Gee’s focus is on

how players learn the overall content of the game and how it is organised. It is through this organisation the player gets insights of the game system and learns to play the game.

The present article follows Gee's overall interest, but where Gee is interested in the macro-level this article is concerned with the micro-level learning dynamics. Investigating micro-level learning interactions (Crawford, 1984) in computer games demands two things: *First* an exemplary computer game to showcase micro-level scaffolding (Vygotsky, 1978) learning steps. In this case Blizzard's acclaimed and successful *StarCraft 2*. It should be noted the selection could just as easy have fallen on a different game such as the mobile game series *Plant vs. Zombies* (PopCap Games, 2009-) or any other game that displays micro-level scaffolding suitable for analysis. Yet *StarCraft 2* was chosen due its exemplary scaffolding of its content with clear incremental steps of rising complexity making it an ideal case for micro-level analysis. *Second* a way of analysing that works well with complex, communicative, interactive feedback systems such as computer games (Juul, 2003; Burgun, 2013, Stenros, 2017). Bateson's (1987) theory of learning is highly interesting in relation to how learning takes place in computer games since it capable of analysing learning on a micro-level and because it contains five aspects all relevant to computer games.

The *first* aspect of Bateson's learning theory stresses learning as a *communication* phenomenon of simple to complex recursive transmissions and interpretations of signals (Ruesch and Bateson, 1968) between systems of human and machine. This is relevant in relation to computer games since they are about communication (Fullerton, 2008, Nijmann, 2013; Schell, 2008). Broadly stated: if the computer game isn't communicated properly, players don't understand the mechanics (Sicart, 2008) goals, challenges, conflicts, structures, or choices they have to make (Salen and Zimmerman, 2004; Costikyan, 2001; Elias, Garfield & Gutschera, 2012; Burgun, 2015; Suits, 2005; Huizinga, 2014; Caillois, 2001). The *second* aspect is concerned with *interaction* and *feedback* (Goetz, 2011, Perry, 2013) between systems hereunder between humans and machines (Crawford, 1984). The *third* aspect is the essential part of Bateson's theory of learning. It draws on Bertram Russell's theory of *logical types*, which states that, "no class can, in formal logical or mathematical discourse, be a member of itself; that a class of classes cannot be one of the classes which are its members" (Bateson, 1987, p. 284). Bateson uses Russell's theory of logical types to outline his four learning categories. It is important to note that their numbering system is in no way indicative of valorisation. The first category, zero learning, should not be interpreted as inferior to learning I, II, or, III. It is strictly

a classification system of increasing complexity. They will, in the following sections, be explained, expanded and used in the micro-level analysis of how learning takes place in *StarCraft 2*. The *fourth* aspect is about *change*. It is the indicator of and condition for learning. “The word “learning” undoubtedly denotes *change* of some kind. To say *what kind* of change is a delicate matter.” (p. 287). Simply put: if there is no change then there is no learning. Change is tied to *movement* from one learning category to the next with increase in complexity. Movement concludes the fifth aspect of Bateson’s theory of learning.

The aim of this article is to present a revision of Bateson’s learning categories applicable both in and outside the realm of computer games.

2 Analysis of StarCraft 2

The following sections present an analysis of *StarCraft 2*. The intension is threefold: to explain and expand Bateson’s learning theory; to on a micro-level analyse how learning takes place in *StarCraft 2* and finally to arrive at a revision of Bateson’s theory of learning.

The analysis uses Bateson’s four learning categories from zero learning, learning I, II to III including his understanding of context. It will introduce temporality to account for the dynamics between learning categories. The first subsections will demonstrate how zero learning, or the absence of learning isn’t a static category especially taking context and temporality into account. It will use *StarCraft 2* which is a science-fiction real-time-strategy game revolving around three competing species each with their own strength and weaknesses. The goal is to combat your opponent using different strategies balancing resource collection, troops and buildings optimally. The analysis will focus on the core of the game: the resource system.

2.1 The first category of learning – Bateson’s zero learning

Bateson’s learning theory have to do with change. Change denotes shifts between learning categories. Naturally it is important to understand how Bateson understand change. In his view is change connected to errors and attempts to correct errors. This perspective also serves to classify errors and attempts to correct errors. Each learning category is concerned with a particular kind of error and attempts of error correction. Bateson writes, “it follows that an ordering of processes of learning can be built upon an hierarchic classification of the types of

error which are to be corrected in the various learning processes.”(p. 291). Zero learning is classified as minimal change in response to repeated input.

Zero learning is interesting since it is twofold. On one side zero learning refers to the present in which zero attempts to correct future events occurs. On the other side refers zero learning to the past where the present act has resulted in successful error corrections. In other words, in the past an error arose, was corrected and now there is no need for any further corrections. It should be pointed out, that taking temporality into account expands Bateson's more or less rigid understanding of zero learning. Adding temporality to the understanding of zero learning is interesting in relation to learning in computer games.

2.2 Zero learning expanded

The temporal understanding of zero learning can be illustrated from the basic construction and resource system in *StarCraft 2*. This system rests on one building: the command centre. The game therefore requires players to identify the command centre, understand its central significance as hub for producing SCV-units (space construction vehicles), and return place for collected resources.

The SCV-unit has two functions: 1) collecting resources such as minerals and vespene gas and, 2) build buildings and repair non-biological structures and units. Without the command centre and the SCV-unit no resources can be collected, and no base can be build and no combat units can be produced. In other words: the player is unable to do anything in the game without SCV-units.

The command centre and SCV-unit are crucial to learning in *StarCraft 2*. Understanding their significance can be viewed in relation to zero learning. Zero learning happens *when* and only *when* the player has gone through a series of error corrections in the process of learning the building and unit's meaning and significance. Essentially demonstration the paradox of failure outlined by Juul (2013) as oscillation between necessary failure to enhance skill or learning as in this case. After that the player repeats his/her understanding without further corrections of errors. The relationship between the command centre and SCV-unit then “falls” into the background of the player's consciousness. The movement of “falling” into the background expresses the result of successful error correction without need for further

corrections. What is left is repetition of already established knowledge. The relationship between the command centre and SCV-unit now becomes tacit knowing (Polanyi, 1983, 1992).

The temporal understanding of zero learning is, as stated, an expansion of Bateson's conceptualisation of zero learning. Bateson focuses on zero learning as the absence of error correction while the expanded understanding includes zero learning as repeated actions resting on the result of successful error correction (see figure 1).

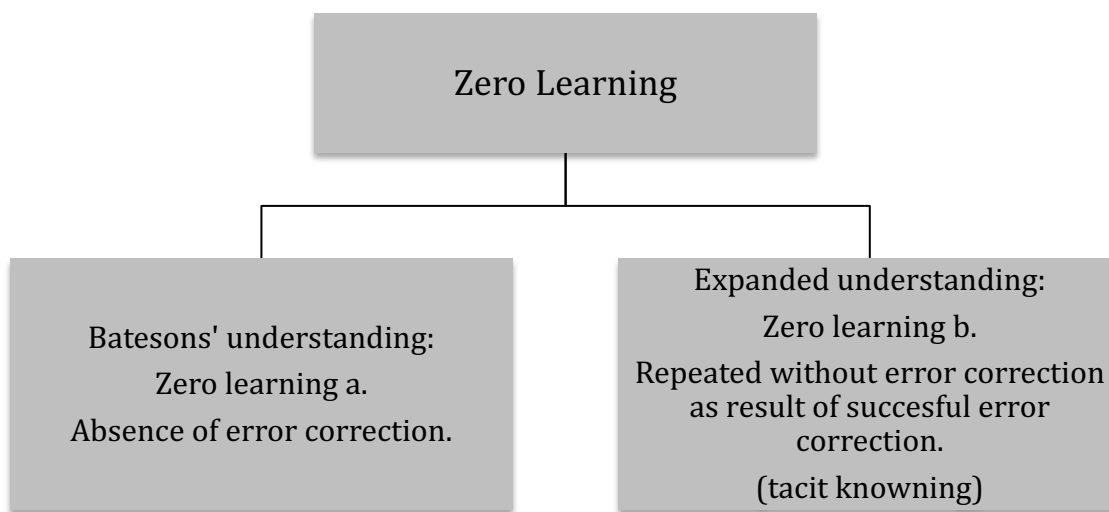


Figure 1: Expanded understanding of zero learning.

2.3 Learning I and the notion of context expanded

Learning I include change as a result of ongoing reflections leading to different responses to the same event. The different responses are based on error correction derived from system feedback. Learning I in *StarCraft 2* happens when the player understands the relationship between the command centre and the SCV-unit communicated though feedback. In computer games are learning I concerned with understanding the relationship between particular buildings and units (system relationships). When connected they seize to be seen as separate and disparate entities, but as integrated “chunks” or “chains” of knowledge. When such “chunks” of knowledge are established they too have the ability to “fall” into the background. When that happens, it converts learning I into what could be called zero learning b (see figure 1). This procedural dynamic is important when understanding how *shifts* between learning categories occur.

Inherent in Bateson's description of learning 1 is an assumption about context. Bateson writes, "the definition of Learning I assumes that the buzzer (the stimulus) is somehow the "same" at Time 1 and Time 2. And this assumption of "sameness" must also delimit the "context," which must (theoretically) be the same at both times." (p. 293) The game system of *StarCraft 2* represents as almost all games do a stable context. The game doesn't change from one play session (Montola, 2008; Mäyrä, 2008) to the next. The game remains the same each time it is being played.

Bateson continues to define context "as a collective term for all those events which tell the organism among what *set* of alternatives he must make his next choice." (p. 294). In the context of *StarCraft 2* the player must choose between a set of alternative actions. The player has to consider whether to produce SCV-units in the command centre or refrain from doing so. Or to be more precise: determining how many SCV-units should be produced.

In *StarCraft 2* context can be divided into fore and background. The foreground is the presented "set of alternatives" from which the player makes his/her choices while the background is the game system understood as a stable repeatable setting (see figure 2).

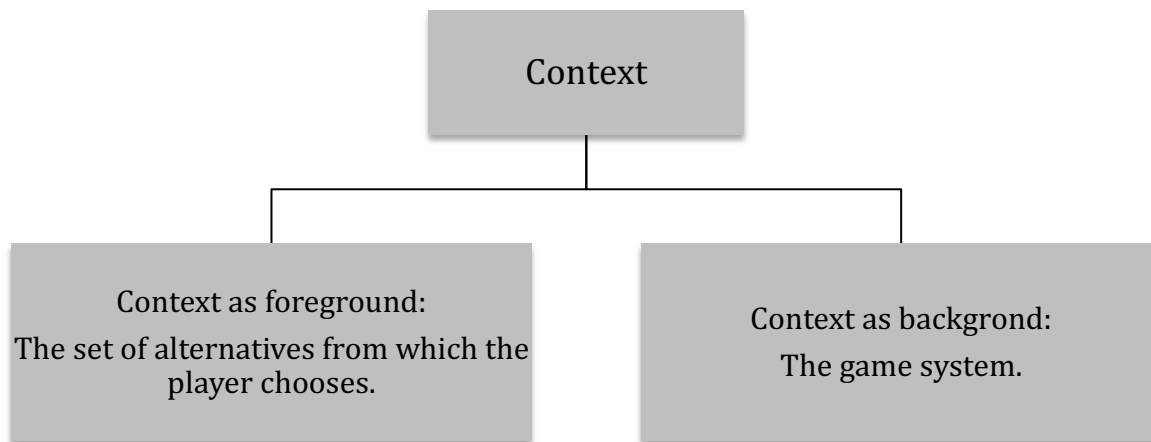


Figure 2. Context divided into fore- and background.

2.4 The dynamics of learning I: Between learning I and zero learning b.

It should be clear by now how Bateson understands zero learning, learning I, and context. Bateson includes context markers in his understanding of contexts. This is relevant in relation to learning how to play *StarCraft 2*.

In *StarCraft 2* and many other games for that matter are context markers important. They can appear either before or during a mission. Usually they appear in the

mission statement. Here the player finds out whether or not he/she should build a base or not. If the mission statement explains that the player should build a base the player is signalled to use already established “chunks” of knowledge which in this case consist of zero learning b: use the command centre to build SCV-units to gather resources. The number of produced SCV-units depends on how the mission unfolds (context). If the player has to collect vespene gas more SCV-units are needed both to build the refinery that extract vespene gas and for collecting the gas (transporting it from refinery to the command centre). The process of choosing between such sets of alternatives taps into learning I. The player now has to expand his/her knowledge by adding another structure, the refinery, to the already established “chunk” of knowledge (zero learning b: the connection between the command centre and the SCV-unit). Now the command centre, SCV-unit and refinery work together in an identifiable sequence (see figure 3) creating a now “chunk” of knowledge.



Figure 3. Identifiable sequence of learning/knowing

The identifiable sequence is created through errors and correction of errors based on feedback from a set of alternatives in a repeatable context. The player can from now on use the identifiable sequence of actions as response to a particular stimuli or context marker. If the player continues to repeat this sequence it will eventually “fall” into the background and become zero learning b. When that happens the sequence has become an automated response of tacit knowing.

This description has one flaw. It describes learning as binary. Either the sequence is being learned (learning I by correcting errors) as the player plays the game or the player has already learned the sequence and it has fallen into the background as zero learning b.

It is possible to inject a dynamic link in the binary view on learning. Claus Otto Scharmer (2001) has described what he calls “not-yet-embodied knowledge” (p.139) understood as knowledge in the process of taking form. Applied to this case Scharmer describes the period *when* learning I is still being formed. The period before it becomes zero learning b

or a “chunk” of knowledge. Before the movement from declarative to tacit knowing. (see figure 4).

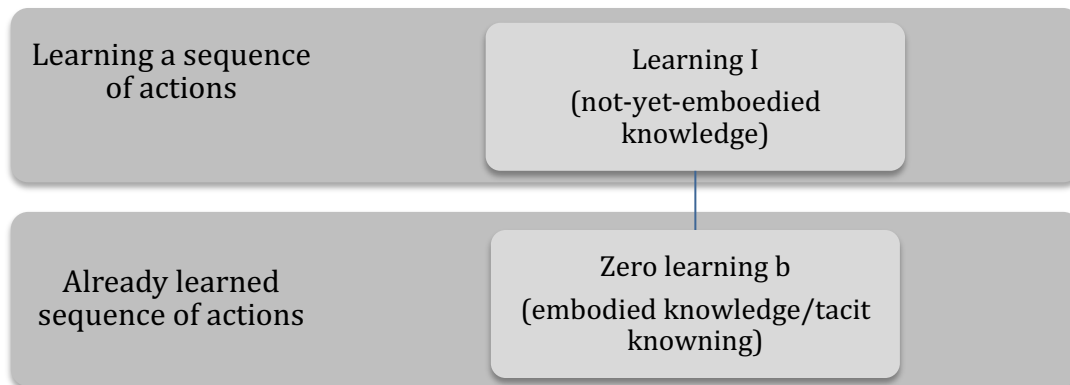


Figure 4. The dynamic movement between learning I and zero learning.

In other words when learning I is taking place it is in a process of forming an identifiable sequence, a series of actions connected from a set of alternatives. At some point in time the selection “closes” or ends. When that happens no more learning is taking place. Learning I have passed from an “open” to a “closed” position. When it “closes” it passes from not-yet-embodied knowledge to embodied knowledge.

This description expands Bateson’s understanding of learning by describing how learning moves from one category to the next through a passage of not-yet-embodied knowledge. Let’s turn to how learning II and how it takes place in *StarCraft 2*.

2.5 Learning IIa and zero learning c

Bateson writes, “*Learning II is change in the process of Learning I, e.g., a corrective change in the set of alternatives from which choice is made, or it is a change in how the sequence of experience is punctuated.*” (p. 298) The quotation is interesting for several reasons. It defines learning II as consisting of two aspects. One is systemic in the sense that it points to choice in relation to the set of alternatives and the other is focused on experience of how the sequence is rearranged or punctuated. Bateson himself doesn’t dive into these differences. Yet they need to be addressed and illustrated especially in the case of learning in *StarCraft 2*.

The systemic aspect of learning II can be seen in *StarCraft 2* when the player is faced with a challenge where prior series of actions or sequences no longer suffice. When the player can’t automatically build a command centre => SCV-unit => Refinery. When the player is

forced to make changes to the sequence building a command centre => 3 times SCV-units => refinery. This change is concerned with numbers of SCV-units. Another change has to do with rearranging the sequence all together. Lets say build a command centre => 1 time SCV unit => Refinery => 2 times SCV-units. These two ways of rearranging the sequence of building structures in *StarCraft 2* are closely connected with both aspects of learning II. The player chooses from the set of alternatives and change the way the sequence is experienced.

Another way learning II is interesting concerns how it like learning I can “fall” into the background and become zero learning in this case zero learning c. This happens through a series of steps. 1) when a learning II sequence is repeated and memorised to the point where it no longer undergoes error correction, 2) it then passes from the foreground to the background. Addressing learning II in this way opens the possibility for dividing learning II in learning IIa concerned with memorisation, repetition, and reproduction (Engeström, 1986) and learning IIb preoccupied with dynamic rearranging learning IIa sequences. Bateson places both within the same category of learning. Memorisation, repetition, and reproduction are interesting aspects in relation to computer games. It echo’s what Koster (2004) calls “grokking”, that is when you learn “something so thoroughly that you have become one with it and even love it. It’s a profound understanding beyond intuition or empathy.” (p. 28). When memorisation has been established though repetition (“grokking”) reproduction “falls” into the background and becomes “tacit knowing” or zero learning b which in *StarCraft 2* would be when the players execute series of learned actions as response to challenges. Such challenges could be “defend base” for X amount of time. Or “build a base” and launch an attack. In both cases it is crucial that the player have learned the sequences thoroughly to avoid waste of time. If the player stalls in executing these series of actions the opponent (AI or human) might get a chance to win.

The overall point is that learning II can “fall” to the background just like learning I, but it results in a different zero learning. Which means it is possible to distinguish between 3 different classifications of zero learning. The first covers Bateson’s original description of absence of error correction, the second is when the player through success error correction establish clear understanding of system correlations (learning I) while the third happens when learning IIa through repetition or “grokking” reproduce series of actions to the point beyond error correction (see figure 5).

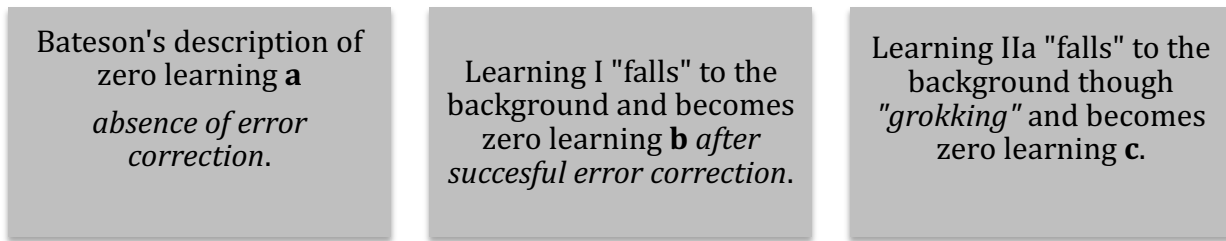


Figure 5 illustrates zero learning a, zero learning b, and zero learning c.

2.6 Learning IIb

Until now I have focused on the dynamics of zero learning, learning I, and learning IIa in regard to *StarCraft 2* leaving learning IIb, which is equally interesting and important. Learning IIb is more complex than learning IIa. Engeström (1986) describe Learning IIb as solutions found through experimentations rather than trial and error as is the case with learning IIa. Learning IIb happens in *StarCraft 2* through experimentations and not on a “blind” foundation. It is connected with insight and understanding of the functionality of the game system (Crawford, 1982, Costikyan, 2001, 2013, Fullerton, 2008, Salen & Zimmerman, 2004). This is a crucial distinction between Learning IIa and b. Learning IIa is about memorisation, repetition, and reproduction as result of “blind” trial and error actions while Learning IIb is about rethinking, recombination, and discovery of new sequences of game units in the game system. It can be argued that Learning IIb is related to the gamer term “meta-game” or “theorycrafting” (Paul, 2011), which refers search for optimal strategies in a competitive game. Learning IIb is about discovering new combinations within an existing game system or context (Donaldson, 2015; Conway, 2010) that in turn can become new “meta-game” strategies. New ways of using units that at first takes the opponent by surprise, but later can become part of play-styles.

Up until now contains the description of how learning takes place in *StarCraft 2*: 1) understanding the significance of the game system units and their correspondent significance (learning I); 2) memorisation, repetition, and reproduction (learning IIa) of learned sequences; 3) rethinking and recombining sequences through experimentation (learning IIb). During the learning process are these sequences able to “fall” back and become zero learning b or c.

2.7 Time and learning

Learning in each play session (Montola, 2008) oscillates vertically between zero learning b and c, learning I, IIa and IIb. Using the word 'play session' encapsulates the time spent playing from loading to exiting a game session. It can take a few minutes or several hours perhaps even days. Addressing learning in each play session doesn't take into account what happens in the time span between play sessions. It is more or less safe to say players think about the game between play sessions. It means that learning also take place during periods of thinking about, but not actually playing the game. Schön's (2000) concept of *reflection-in-action* is helpful when trying to capture learning between play sessions. Reflection-in-action can extend beyond each play session by incorporating time before and after each specific play session.

Reflection-in-action can be said to mirror Bateson's learning IIb. Especially since Schön underscores reflecting (rethinking and recombining) in a specific situation. But Schön doesn't limit reflections to the particular situation. He includes time before and after the specific situation. This means Schön's concept of reflection-in-action can be divided in two. The first concerns the particular play session, which could be coined *situational reflection-in-action*, the other encapsulates the extended game engagement sometimes lasting several years, which could be coined *episodic reflection-in-action*. The point of these distinctions is to draw parallels between situational reflection-in-action and learning IIb, and to include learning to encompass a longer period of time – the entire time a player is engaged in a game as in this case *StarCraft 2*. Making such distinctions help to differentiates between learning during the particular play session (situational) and learning as taking place over the entire time span the player is involved and engaged (episodic) in a game. The latter form of learning could be called learning IIc.

Learning IIc is interesting for two reasons: the first concerns individual learning while the second includes a social dimension where the player communicate with other players that share similar interests. Together they form what Gee (2003) have coined affinity groups. The individual dimension is centred on personal reflections on the game's challenges while the social (Lave & Wenger, 2003; Bruner, 1990) dimension is engage in reflections in fora's where other players participate with their considerations, experiences and reflections.

Affinity groups are organized around, in the case of *StarCraft 2*, members reflecting on discrete parts of the game *and* the system in its entirety. This means that group members take part in reflections and considerations that regard all aspects of *StarCraft 2*. Gee's

understanding of affinity groups helps to create a bridge between the individual player's reflections and fellow players insights. Such affinity groups constitute a reflective practicum from a shared interest.

These considerations leave out one extension of learning II that is also inspired and guided by Schön (2000) especially his description of *reflection-on-action*. It concerns, as Shaffer (2006) correctly observes, reflections “when one looks back on a completed task or process to consider the implications and consequences of actions.” (p.96). Reflection-on-action is evaluative and happens after players have stopped playing *StarCraft 2* altogether and look back and evaluate the entire process. This evaluative look could within the frame of Bateson's learning theory be coined learning IId. See figure 6 below to get the “full picture” of the distinctions involved and different kinds of learning II when time spans are including in the distinctions.

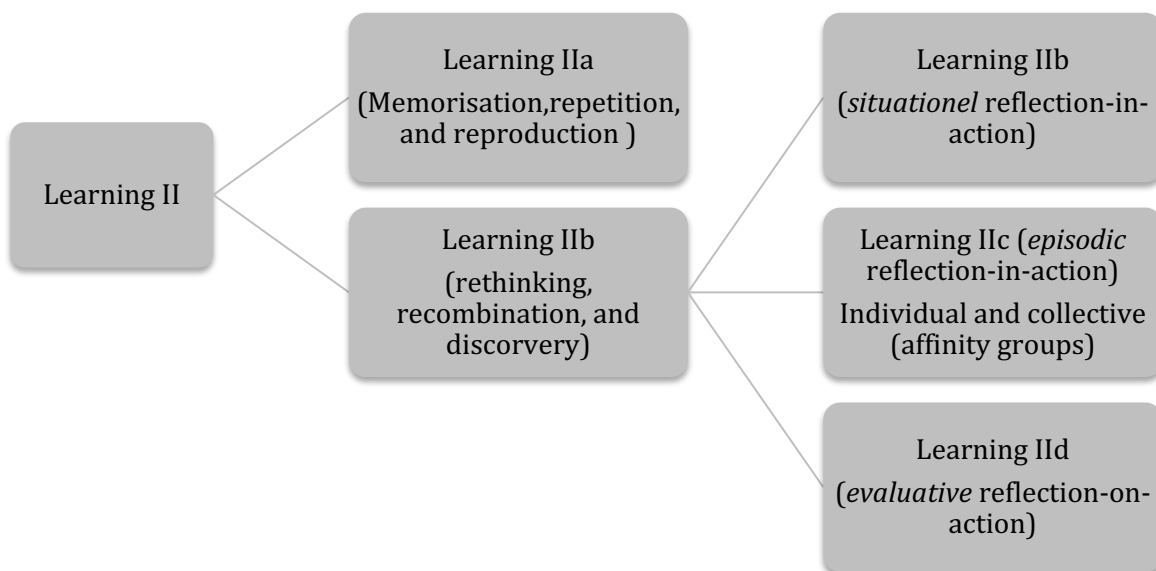


Figure 6 illustrates the conceptual diversity of learning II when time spans are included.

I will only add a few remarks to Bateson's understanding of learning III. While learning I, IIa, b, c, d concerns changes and organisation within the confines of a repeatable context from the set of alternatives constitute learning III reconfiguration of the entire context. Connected to the present case it would amount to a radical shift in the organisation of the player's psyche leading to leaving *StarCraft 2* to become a game designer, programmer, game artist, or quitting computer games altogether to do a host of other things. Learning III concerns

life-altering events and is not, as Bateson himself point out, something that educational systems should aim for since it is perilous, and the results can be dangerous.

3 Supporting concepts in a revision of Bateson's theory of learning

Before presenting a revision of Bateson's theory of how learning takes place in computer games based on *StarCraft 2* and inspired by Schön, Shaffer, and Gee it is necessary to outline four key concepts of which the revision is based and dependent. These are difference, identity, expansion, and (self)referentiality. They will be explained in the following sections beginning with difference and identity.

3.1 Difference and identity

Bateson's theory of learning depends, as already described, on change, but it doesn't directly include considerations on how objects of learning can be separated from each other. We have to look elsewhere in Bateson's *Steps to an Ecology of Mind* (1987) in search of answers. In the article *Form, Substance, and Difference* Bateson conduct an investigation of difference. He advances an argument build upon Korzybski's dyad on difference between the terrain and the map of the terrain. Korzybski's dyad is about the relationship between particularity and generalisation, concrete and abstract, or content and context. Bateson sees an analogy between Korzybski's dyad and his understanding of learning. Especially Korzybski's concern about selection of what from the terrain that makes it into the map and what doesn't. The selection is guided by difference. In Korzybski's terrain-map relation it is things like altitude, surface, vegetation, or population that make it on to the map. Using this line of thinking on *StarCraft 2* is becomes clear how the command centre stands out as a difference that makes a difference. This observation is fairly straightforward.

Bateson moves beyond such trivialities by investigating the concept of difference in itself by asking the question: what is a difference? Difference is, as Bateson observes, "a very peculiar and obscure concept" (p. 458). Difference is not a thing or event. Bateson finds that there are different kinds of differences and they should be classified.

Derrida (1982) have another take on difference. He regards difference not as a concept in the Kantian sense of the word or as an ontological phenomenon, as Heidegger would see it (Author, 2012). Derrida invents a new word for difference. He does so by deliberately misspelling difference turning it into a new word, *différance*. Derrida derive two meanings of *différance*. The first has to do with time while the second has to do with spacing. Temporisation is distinctions in time between past, present and future while spacing is about separation between near and far or to be more precise presence and absence. The presence is allusive since it always has passed and therefore never truly can be or is present. Presence leaves a trace shaped by the absence of the present. It then seems, abbreviated of course, that *différance* in Derrida's understanding both is and functions as condition for and possibility of everything. Bateson doesn't see difference in that scale. He is concerned with difference from the perspective of the observer. The observer is critical since it is he/she that selects from the set of alternatives, but the selection is made from "an infinite number of *differences*" (Bateson, 1987, p. 460) surrounding an object and its context. The short version of Bateson's understanding of difference rest upon, a) contrast between the observer and the object, b) guided by the observer's selection among a set of alternatives. This line of thinking places difference as something happening in both the fore and background. The foreground being the contrast between observer and object while the background is the set of alternatives. In practical reality they are inseparable.

The common ground between Derrida and Bateson's understanding of difference is that it can't stand-alone whether it concerns *différance* as temporisation and spacing, as a trace shaped by the absence of the present or conceived as a difference that makes a difference.

Looking closer at difference and Bateson's understanding of difference as distinctions between the fore- and background it is revealed that difference can't be understood without identity. Identity should here be understood as sameness, connectedness, or affinity between that of which a difference is part *though* its difference. Bateson then on one hand sees difference as difference *from* something (between fore- and background) *and* on the other hand as identity, when a difference connects itself to another difference of the same kind something he unfortunately doesn't explicitly write about. These abstract formulations are dense but can be unpacked using Korzybski's terrain-map dyad.

The mountain on the map may step forward as a difference from the anything else on the map, but it can be argued that the mountain also is connected with other mountains

though identity (sameness). They have something in common. In this case: being mountains. It means that a mountain is different from everything else on the map that isn't a mountain, while sharing identity with other mountains.

In *StarCraft 2* as already mentioned constitutes the command centre a difference that makes a difference since it is different from the terrain, but it shares identity (sameness) with all other constructions (buildings) in the game. Understanding difference this way is productive since it makes it possible to point towards differences that make a difference through connections by identity (sameness). Inherent in this line of thinking is that difference only is possible through some sort of connectedness or context. A difference is difficult to observe as difference without some sort of identity through some kind of sameness which in turn creates a background or context.

The next two concepts that will be presented are expansion and (self)referentiality before finally moving on to the presentation of a revision of Bateson's theory of learning in relation to how learning takes place in *StarCraft 2*.

3.2 Expansion and (self)referentiality

Learning expands in *StarCraft 2* parallel with rising complexities through introduction of new buildings, units, and functions, which the player has to identify as well as understanding especially their mutual relationship. Scaffolding such complexity means that the player has to expand learned sequences of learning I by continuously adding to what was already learned. It is more or less safe to say, that learning I expand the more the player plays. The same goes for learning IIa, b, and c.

Bateson doesn't address expansion in his theory even though expansion takes place by joining together differences that make a difference with each other by identity in increasingly complex sequences of learning I and IIa, b, and c. Increasing complexity happens when differences through correspondence with each other by sameness are joined. This understanding of difference and identity rests on correspondence. And such correspondence infers reference between differences and identities. The workings of reference are both as 1) reference and 2) self-reference. 1) A difference refers to or contrasts what is different from it while 2) self-reference infers reference by sameness or identity.

This can be unpacked to ease understanding. Difference, identity, expansion, and self-referentiality takes place in four ways; 1) a difference makes a difference (the mountain is different from non-mountains on the map (reference)); 2) a difference connects to a similar difference through identity (the mountain makes sense by referring to another mountain and the other way around (self-reference)); 3) differences and identity works in plural (series of mountains are different compared to the background of non-mountains); 4) differences joined in groups of differences by identity so as to make a difference (mountains as a group makes a difference compared to others groups of differences (forests)).

This way of understanding and seeing relationships between difference, identity, expansion, and (self)referentiality draws the initial line to a revising of how scaffolding content and context works or how learning takes place in *StarCraft 2*.

4 A revision of Bateson's learning theory based on StarCraft 2

As already stated constitutes the command centre in *StarCraft 2* a difference that makes a difference. To fully understand the command centre as a difference that makes a difference it needs another difference that makes a difference namely the SCV-unit. The player only fully understands both the command centre and the SCV-units significance when they are tied together in mutual relationship. This happens through reference to each other. This reference creates a shared identity. The two units belong to each other. This recaps how differences create or enter into a mutual relationship of shared identity by (self)reference.

This can be described formally as difference A and difference B acting as differences that make a difference and create a shared identity 1 in relation to the background, frame X. The shared identity 1 of difference A and B constitutes the first impetus toward a context Z.

Frame and context are two different things. In *StarCraft 2* is the command centre and SCV-unit differences that create a context (in which the units are parts), but the context takes place within the frame X of the game (the entire game system).

The chosen word impetus covers exactly an impetus since context X isn't yet complete. Context should be understood as a "collection" of differences of shared identity. Heidegger (Heidegger, 2010) has an enlightening determination of such a collection and their shared relationship in his understanding of "useful things" (§15, p. 68). Such *useful things* are

things to do something with (Dreyfus, 1991). The *useful things* are such due to their “serviceability, helpfulness, usability, handiness, [and together they form] a totality of useful things.” (Heidegger, 2010, §15, p. 68). The command centre and SCV-unit are indeed *useful things* in *StarCraft 2*. The mentioned totality in the quote is what I call a shared identity. Heidegger continues to write that “pen, ink, paper, desk blotter, table, lamp, furniture, windows, doors, room.” (§15, p. 68) belong together through reference. Idhe (2010) explains the reference like, “this is to say that any given equipment is what it is in an equipmental context and that it appears in such and such a way relative to the context” (p. 49). The *context* for useful things happens within the *frame* of the house. This is exactly what happens in *StarCraft 2*. The command centre and SCV-unit are useful things that functions in relation to each other as part of a context of *useful things* in the *frame* of the game system.

The dynamics of differences in *StarCraft 2* then works like this: when the command centre and SCV-unit have been perceived as differences that makes a difference through shared identity other differences becomes evident. First it is the blue crystals in the landscape next to the command centre. It is those crystals, as already explained, that constitute the resources the SCV-unit have to collect. Adding a difference that makes a difference to a collection of already established differences that make a difference marks an expansion of the already shared identity 1. Now the shared identity of differences (command centre and SCV-unit) include a new difference, the blue crystals (resource) and expand the shared identity 1. This procedural expansion can formally be described as difference A and difference B that through reference to each other form shared identity 1 in frame X, now connects itself to difference C (blue crystals). The expansion of differences rewrites the relation between differences A, B, and C, which now form, shared identity 2. Formally this process can be described like this:

1. Difference A (command centre) in frame X (game system)
2. Difference A and B (SCV-unit) form a shared identity 1 (command centre and SCV-unit) in frame X that creates the impetus to context Z (collection of useful things: command centre and SCV-unit).
3. The shared identity 1 expands and connects to difference C (collecting resources: blue crystals). It now becomes shared identity 2 in frame X creating the second impetus to context Z.

Learning in *StarCraft 2* doesn't end here. It continues to expand. The player quickly learns that the SCV-unit isn't limited to collecting resources. It can also act a construction vehicle just as its name suggests. Formally this means that difference C (resource collecting) now connects to difference D (construction). In *StarCraft 2* the SCV-unit construct the Refinery (to extract vespene gas) and collects the extracted vespene gas. This adds yet another difference E (collecting vespene gas with the SCV-unit). Now the player sees the SCV-unit as central to collecting resources (minerals and vespene gas). Together this form difference F. Now these procedural expansions can be added to the formal descriptions above making the continuation look like this:

4. Shared identity 2 (difference A, B, and C) connects to difference D and become shared identity 3 in frame X. This creates the third impetus to context Z (shared identity 1, 2, and 3).
5. Shared identity 3 (difference A, B, C, and D) connects to difference E and become shared identity 4 in frame X. This creates the fourth impetus to context Z (shared identity 1, 2, 3, and 4)
6. Shared identity 4 (difference A, B, C, D, and E) connects to difference F and become shared identity 5 in frame X. This creates the fifth and last impetus to complete context Z (shared identity 1, 2, 3, 4, and 5).

Shared identity 5 completes context Z in *StarCraft 2*. Context Z is the games basic resource and construction system (other contexts can be created made from *useful things* (buildings/units/functions) to combat the enemy). This formal description ends the presentation of a revision of learning drawn from difference, identity, expansion and (self)reference to describe scaffolding of content and context or how learning takes place in *StarCraft 2* and any other computer game for that matter.

5 Conclusion

In summery the outlined revision of how learning takes place in *StarCraft 2* is built on Bateson's learning theory together with the concepts difference, identity, expansion, and (self)reference

to properly handle scaffolding content and contexts. This presented revision handles successive expanding complexity both vertically and horizontally. It should be noted that the revision doesn't view learning as happening in an always-linear way, but instead considers learning heterogeneously as an expanding mix of vertical and horizontal connections between already established differences, shared identities, and/or contexts. The increasing or expanding complexity handled by the revision shouldn't be viewed as a coordinate system of vertical and horizontal axes but perceived as an organic and spacious tissue that continually is being shaped and reshaped during the learning process. The analogy to a spacious tissue is intentional and underscores that learning should be understood as a matrix similar to Deleuze and Guattari's (2005) description of the rhizome.

Finally, it should be noted that the presented revision can be applied on a host of other games from locally run or globally executed games on all kinds of devices. The point being that *StarCraft 2* was selected because it exemplarily demonstrates how scaffolding learning and context works in computer games. As stated in the introduction could the mobile game *Plant vs Zombies*-series (PopCap Games, 2009-) just as easily have served as case material since it also does a good job scaffolding content and context. This means that the presented revision of how learning takes place in *StarCraft 2* can be broadening to include how learning takes place in many other games. Such a statement requires refinement. It is not every computer game that equally well scaffold its content or shape its contexts. Many do not. They either move too fast or too slow meaning they either present too many details too fast or not enough quickly enough. This only points to the revisions applicability since it demonstrates the sensitivity (micro-level) of how scaffolding content and context works. The presented revision can be used as a guideline for designing stepwise introductions of game content to ensure and secure players learning of how to play the game. This will minimize the risk of players rejection of the game. The presented view on scaffolding learning isn't limited to computer games. It can be applied in any learning scenario on any level of education since all learning is dependent on scaffolding content.

Competing Interests

The author declares that there is no conflict of interest regarding the publication of this article.

Ludography

Plant vs. Zombies (PopCap Games, 2009-)

StarCraft 2 (Blizzard Entertainment, 2010-)

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