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Reflection-in-Action and Motivated Reasoning

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Abstract: *Reflection in design pedagogy still has a limited theoretical basis, being based largely on historical precedent and the more recent work of Donald Schön. Discipline criticisms of reflection in design pedagogies and curricula have yet to be addressed fully and, compared to other disciplines, design has relatively little critical debate around the theory and practice of reflection. Research in other domains, notably psychology and cognitive neuroscience, presents challenges to this view of reflection as some process of objective observation. This paper presents a modified view of design reflection taking account of these latter challenges and a framework for analysis of written reflection is given. Evidence using this framework is presented using a sample of design student written reflection. The results, albeit from a small sample size, suggest that the value of reflection in design education is perhaps not in its 'truthfulness' but its utility as part of the design process.*

Keywords*: reflection-in-action; motivated reasoning; design pedagogy; reflective practice*

1 Introduction

Donald Schön's model of reflective professional practice has influenced a generation of designers and design educators. Schön's work, based in turn on that of Dewey (Schön, 1992, 1987), helped validate existing design pedagogies by providing a theoretical basis whilst still preserving the uniqueness and position of them in relation to other subjects.

Schön was also contributing (at this time) to setting design theory on a more rigorous foundation – a newer epistemology that was neither the preceding informal notions of design or the recently emerging rationalised process views (Cross, 2007). Any theory of design pedagogy had to address the observation there are tacit, incomplete and uncertain elements to the practice of design (as well as many other professions and disciplines). The designers' inability to articulate successfully their own thinking was a significant motivation for this activity. Reflection -in and -of Action fitted this paradigm nicely.

As Webster (2008) points out, however, the wholesale adoption of the theory has taken place without effective scrutiny of much of the detail, leaving the theory itself with a number of internal inconsistencies and contradictions. As Webster summarises 'Even those who have signed up fully to the reflective paradigm avoid confronting these issues…' (Webster, 2008). Perhaps ironically, 'reflection-on-reflection' itself takes place less frequently than it perhaps should in design.

In addition to subject problems, recent developments in psychology, cognitive neuroscience and sociology have yet to transfer their findings to design reflection as a general and subject specific practice.

This paper argues that if we are to continue with any notion of self-reflection in design education, these issues have to be addressed. It will present some of the main challenges from other knowledge domains and then demonstrate how these problems can be used constructively in the subject of design itself.

We start by looking at some of the current issues around the theory, science and practice of reflection.

2 Problems with reflection

2.1 Problems in the mind

In the past few decades, advances in social psychology and cognitive neuroscience have allowed new insights into human thought and cognition. But it is only very recently that such findings are making their way to theories of design pedagogy, despite their clear relevance to meta-cognitive acts such as reflection. This paper takes one very important theme that has emerged over the past few decades – our awareness of our own thinking.

Essentially, we are mostly unaware of our thinking because most cognitive processing is unconscious. More precisely, we are not 'aware' of much of the processing that takes place in our brain and central nervous system (Nisbett & Wilson, 1977; Lakoff & Johnson, 1980; Crick & Koch, 1995). As a quick example, how we see ourselves is rarely how others see us since our self-perception is rarely objective truth; indeed it actually depends on a degree of 'dishonesty' (Mazar et al., 2008).

So it is perhaps not much of a surprise that our memories of the past cannot be relied on in terms of it being some objective store of information or data – they simply do not work as repositories or like accessing a storage device. Memory is, cognitively speaking,

more of a re-construction than a re-collection (see Mlodinow (2012) for several examples or Schooler and Engstler-Schooler's (1990) six experiments demonstrating how other cognitive processes affect the accuracy of memory).

Similarly, the world outside our own heads is far less the objective and collectively agreed reality we might think. Much of 'reality' is filtered, in our minds based on our ideas, preferences, feelings, biases, prejudices, etc. As soon as the definition of reality relies on the cognitive processing of people, any notion of an objective reality has to be set aside. As Hastorf and Cantril state '… the data here indicate that there is no such 'thing' as a 'game' existing 'out there' in its own right which people merely 'observe.'' (Hastorf & Cantril, 1954).

Even at a conscious level, when we behave in a particular way we prefer to believe that there are clear reasons behind such behaviour. But we are often actually acting on subconscious 'decisions' that we are only justifying consciously (e.g. Kunda, 1990; Dunning, 2006). This process, known as motivated reasoning, is one we are generally unaware of yet we use it regularly in our daily lives. For example, we are often surprised by things we would rarely acknowledge affect our purchasing decisions (e.g. Spence & Gallace, 2011) and we use social norms to explain our behaviour when interviewing (e.g. Nisbett & Bellows, 1977)

Basically, we 'lie' to ourselves about our thinking, how we see ourselves and how we see the world around us. Moreover, we are particularly good at constructing reasons for these 'lies'. There are, of course, good reasons why we do this and it is in no way a bad thing in and of itself; such basic 'dishonesty' is simply a necessary part of efficiently using our cognitive processes. But it can get in the way, such as when we are unaware of our own knowledge or skill limitations in education (Kruger & Dunning, 1999). And it can be a problem when we are concerned with activities that rely on us thinking about why we do things – activities such as reflection.

In design education, this may represent a particularly important consideration. Research shows that creative thinkers are better at motivated reasoning than others (Ariely, 2012; Gino & Ariely, 2012), meaning they may also be less aware of this too. Many design researchers acknowledge this issue, perhaps best summed up by Lawson (2005) when he observes that 'seeing' the thinking process of design in action is effectively impossible. It is argued that this impossibility holds true for the designer themselves as well as the observer.

As Mlodinow (2012, p. 19) summarises, '…we humans have an odd mix of low ability and high confidence.'

Clearly self-reflection in design education has to be (re)considered with this in mind.

2.2 Problems in the theory

Reflection is a word that is universally understood yet suitably vague: we all understand what it means but struggle to explicitly define it's meaning. So it is unsurprising that there is no detailed and agreed definition or theory to underpin all reflection in education and practice. In literature, for example, consider Dimova and Loughran's (2009) overview of recent historical perspectives on reflection (considering Dewey, Schön, Vigotsky, Lefebvre, and Shchedrovitsky); or McCarthy's (2011) highlighting critical, premise, and emancipatory types of reflection; or Barnett and O'Mahoney's (2006) review of the process models for reflection.

One common element does emerge in almost all reflection theories, however: each one assumes our thought process(es) to be some cognitive activity that can be discussed as if it were some 'thing' – mostly a discrete, conscious, process. Of all the theories of reflection listed in Dimova and Loughran (2009), only one (Schön's) allows reflection to be subconscious. Interestingly, none of these main theories considers reflection as an embodied cognitive process - only Shchedrovitsky allows it to be an action that is then reflected in the mind.

Another element common to most theories is that there is some objective reality that can be reflected upon. Such an idea of a normative, objective reality is difficult to maintain in current metaphysical philosophy, so its assumption in a subjective domain such as reflection is somewhat strange. Most theories have never really needed to deal with their ontological consequences since the proximity of thought to reality is such that the distinction is assumed to be irrelevant. But as soon as we view reflection as an enacted thought process, as it is with Schön's reflective practice model, we have to address the problem of objectivity (Schön's original arguments were thoroughly grounded in the pragmatic tradition in philosophy).

In summary, these points are called into question in reflection theory: the mechanisms of reflection (that it is a specific cognitive process itself or some combination of other processes); and objects of reflection (that there is some objective reality that may be reflected upon).

2.3 The challenge for reflection

In summary, any theory of reflection is now faced with two main problems. Firstly, that much of our cognitive processing takes place without us being consciously aware of it: that the reasons and motivations we claim are behind our actions are rarely as transparent as that. Secondly, any theory of reflection has to recognise that it can never be reflective of some purely objective reality: that the very meaning of reflection in the physical sense (rebound, repeat, reproduce) is inaccurate.

These problems may seem insurmountable; after all, if we cannot trust our own thoughts or even memories of reality (and that notions of an objective reality are in question), what is left in terms of 'knowing' anything? This question supposes that objective truth is what is valuable in reflection. It may certainly be what we assume the subject of reflection to be, but that does not necessarily mean that it is the value of it to either the student, tutor or even practitioner.

To consider an alternative frame for reflection, a conceptual approach is now constructed by considering the nature and utility of it in a design context.

3 The opportunity and conceptual approach

3.1 Subject of reflection

The problems identified arise (at least in part) because people are the object and subject in the process of reflection: we cannot reflect on our thoughts without thinking those very thoughts. In other words, there is no reality that we are not part of about which we can reflect objectively.

In design, the ability to bridge such apparent contradictions and dualities is part of the creative design process, a mechanism similar to what Cross (2011) refers to as 'stimulus of conflict' in a context that Koskinen et al refer to as the 'halfway' between people and things (Koskinen et al., 2011). It is this simple ability of designers to hold multiple realities (and even contradictions) in their heads that gives our first clue about reframing reflection: it does not necessarily have to be true, merely useful to the process.

We are now not interested in reflection as a phenomenon that has some objective value from multiple points of view, but simply as a useful activity that is applied functionally as part of a larger process. The utility of reflection as a means to establish truth becomes less relevant since it is the process itself that is the functional characteristic of interest.

This argument is supported by Goldman (2004) who proposed introspection to be a *mental* process as opposed to a conscious one. By this view, reflection is neither conscious nor subconscious; neither truth nor lie. It is simply something that happens cognitively – something closer to Eraut's 'metaphor for thinking' (Eraut,1994 in Webster, 2008).

3.2 Value and utility

We cannot ignore the fact that reflection seems to have some value; that there is something useful that people experience about the process of reflection. Even if we limit our consideration to the difficult cognitive processes outlined above, there is a significant body of evidence to suggest that reflection can still be a valuable and useful process.

Simply being aware that our conscious thinking is affected by other cognitive processes is often enough to affect implicit motivations. Reflecting on such biases can assist with exploring tacit assumptions and affecting category bias. Mlodinow (2012), provides a good summary in literature of breaking such assumptions along with his own examples of actively engaging in such reflection. Hickson's (2011) own case study demonstrates the utility of Fook and Gardner's (2007) deconstruction/reconstruction model and asking certain critical and exploratory questions. Wetzstein & Hacker (2004) demonstrate the value of explicit, externalised reflection during (and as part of) the design process.

Considering the utility of such reflection, however, leads us to the same problems we face with the ontology of reflection – how can we know the reflection is useful? How is its value measured?

Once again, it is the practice of design itself that provides a way forward. Being able to determine the limits of a subject, or the conditions by which we might consider it, is a core skill that is common to leading design practitioners (Cross, 2011). Whether we theorise these as Rittel and Webber's (1973) 'wicked problem' conditions, Schön's frame/re-frames (1987), or Dorst and Cross's problem/solution coevolutions (2001), they are all methods with a similar epistemology – the subject and context shift as both set the conditions under which something useful may be achieved.

It is only by accepting that value is a relative term that designers can proceed with design. Recognising and working within such 'fuzzy' domains of knowledge and certainty is a discipline skill that is also applicable to the theory of that discipline. Again, it is proposed that this design analogy holds for reflection. The value of reflection is a relative one: if it is serving the process within the context(s) set for that process, then it is valuable.

Goldman supports this position from a slightly different perspective when stating 'A crucial problem for the theory of introspection is to fix its range of reliability' (Goldman,

2004, p. 14). It is argued that such fixing is a necessary part of the act of reflection as framed in design education: that the value of reflection is relative (and even changing with respect) to the context of the process itself.

3.3 Starting hypotheses and questions

In summary, we now have a starting framework in theory that reframes reflection as a 'potentially valuable cognitive process', not a process of discovering truth or even reality. The value is in the utility of the process of reflection itself in a given context, which is itself emergent and relative. Specific attention is paid to motivated reasoning because the constructions of reasons are rarely considered compared to the assumed truth they represent.

For these reasons we expect see evidence of motivated reasoning in student reflection and see a greater frequency of it in successful students and less of it in less successful students. We would also expect to see better reasoning, at least in terms of value to the process that is the subject of reflection. A further hypothesis that follows directly would be that the frequency and quality increases as students successfully develop their design experience and abilities (and that it does not change or even reduces in students who do not develop).

In summary, the study is now looking for evidence that potentially valuable cognitive processes have taken place by identifying explicitly given reasons since these represent motivated reasoning, a key cognitive process in reflection.

The following starting questions follow:

1. Do we see greater frequency of motivated reasoning in successful students (and/or the inverse in less successful students)?
2. Do we see greater 'better' reasoning in successful students (and/or the inverse in less successful students)?
3. Does the frequency and/or quality of motivated reasoning increase as students successfully develop their design experience and abilities?

4 Study and method

4.1 Context

The Open University (UK) provides distance-learning higher education across the UK and internationally. Students study individual courses (or modules) that contribute to qualifications in a range of subjects at under- and post-graduate levels. Core learning material is provided to students physically or digitally using an online Virtual Learning Environment (VLE).

This material is designed to allow learning at a distance and contains everything students require in terms of information, activities and assessment materials. Students are supported by a tutor responsible for around 20 students in a single tutor group. Tutors are the direct point of contact for students studying at a distance and provide support in the subject area, general study skills and advice and pastoral care.

A further key aspect of The Open University is the open access policy - students require no previous qualifications or evidence of study to undertake a course of study. This ensures that the university maintains a very diverse student population, in all demographic senses.

In design education it has a particular significance in terms of 'self-selection', where other institutions will find themselves with students who have some specific notion of a particular discipline oriented career or study path (Lloyd & Jones, 2013).

The design qualification (BSc in Design and Innovation) comprises three core design modules and three other single subject modules based on the design pathway chosen (Art, Engineering, Environment and Business). These modules are provided at increasing levels of study and it is the entry-level course U101: Design Thinking that is the context of the study presented here.

Students' undergo assessment at regular points throughout their study of U101. The course is divided into four blocks of around six weeks study and at the end of each, students submit a piece of work that is formally assessed by their tutor who provides written tuition feedback. This continuous assessment is a key feature of the OU tutorial system and provides students with checkpoints to reflect on their progress and to develop their work in future assessments. The submitted work is known as the Tutor Marked Assessment, or TMA.

Put together, this model of distance education is the Supported Open Learning (SOL) model (Ison, 2000).

A key feature of U101 is the focus on the assessment of student design *process*, not final product. To communicate this, specially designed concept mapping software was developed and is used by students to represent key steps in their process. The software, CompendiumDS, is a 'digital whiteboard', in which 'nodes' can be arranged spatially, similar to a mind-map (Figure 1) but with a richer set of artefacts. Nodes can consist of a variety of media and these can be connected to allow patterns to be represented, communicating the process of thinking and acting undertaken (Jones, 2014).

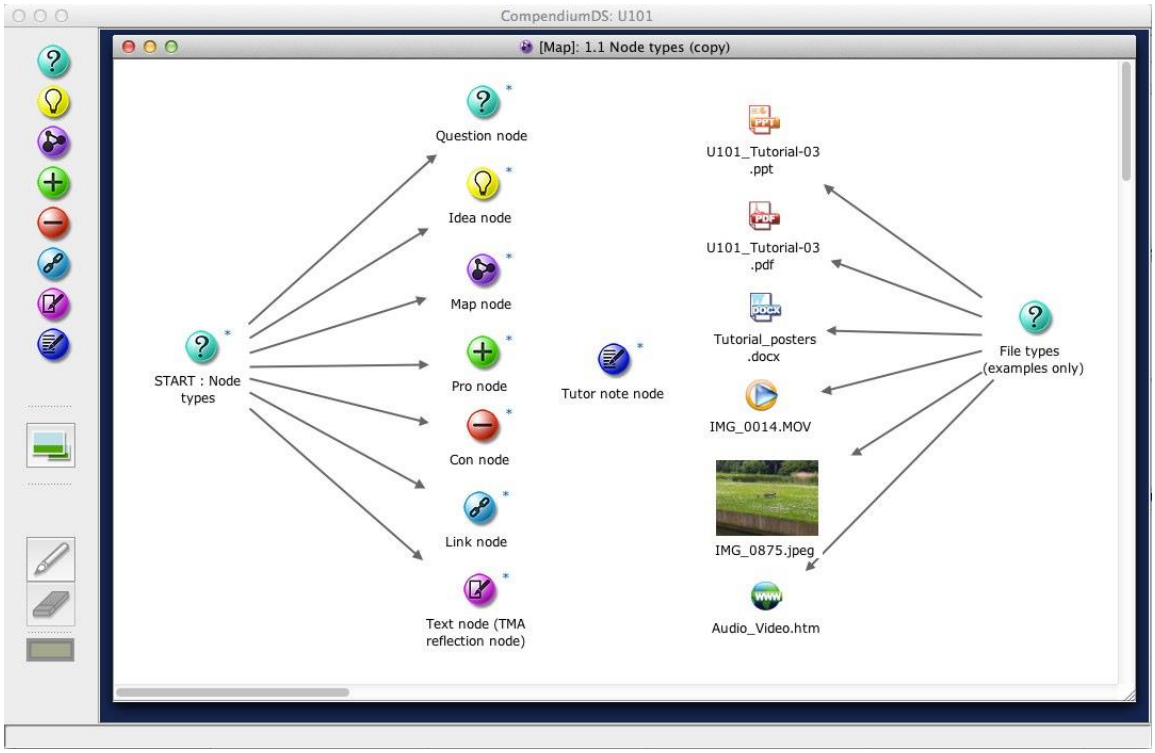

Figure 1 CompendiumDS software showing interface and nodes

The main object of assessment submitted by students are these project maps prepared in response to instructions and prompts in the module material. Four substantive TMAs are submitted in addition to a final End of Module Assessment (EMA) to complete the learning outcomes and produce a portfolio of work.

Part of the mapping process is reflection on the process itself – both as students go through the process (reflection-in-action) and when they complete it (reflection-of-action). Figure 2 shows an early TMA map where students are guided through the design of a t-shirt. The nodes with light bulb icons are completed with images of their process and the pen and paper icons are the reflection nodes. This reflection is text entered into a dialogue box in the software itself.

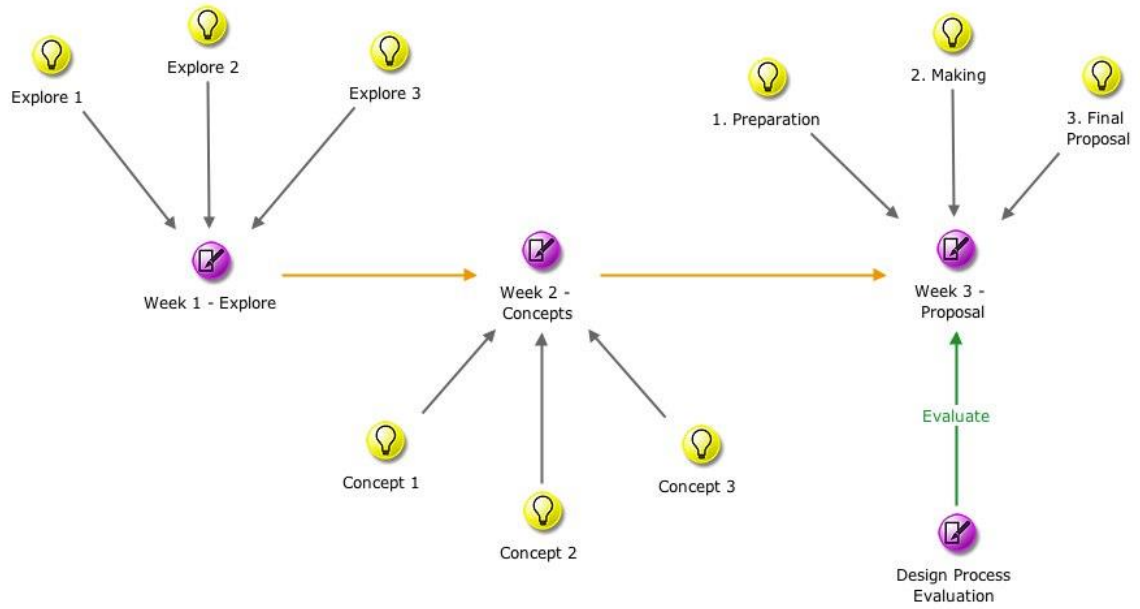

Figure 2 CompendiumDS map layout for TMA01

Students are prompted to reflect in different ways as the course progresses. The initial assessment provides structured questions that make students consider basic reflective ideas (their feelings, thoughts, actions, etc.) in order to help them develop their own habits of reflection. As the course progresses, students are given fewer prompts and expected to be able to construct their own reflections as a useful part of the process of design.

4.2 Approach

From the starting hypotheses and questions, a means of identifying motivated reasoning in written reflection was required. This in turn required an understanding of how motivated reasoning might express itself in written reflection. It was recognised that this would be difficult in terms of identifying the construction (by students) of such motivations so a constructivist grounded approach was adopted to analyse the reflection text to draw out themes (Charmaz, 2000). The purpose of this was to provide a simple, consistent coding that could be applied efficiently using identifiable themes or objects.

This process was repeated through several iterations and a range of theme elements emerged around the objects students discussed: Actions, Processes, Emotions Thoughts and Preferences. But there remained the difficulty of isolating these elements and describing motivated reasoning to them singly. For example, a student may have stated 'I did X because I felt Y' and this is a clear reason, but it has two themed elements: the subjects activity X and emotion Y. This makes it difficult to say it is a reason based on either activity or emotion (or some combination of both).

The conceptual approach outlined above was then used between iterations to deal with this difficulty – since it is almost impossible to state whether reasons are constructed by students using particular subjects, we observe only that reasons *have been* constructed. In other words, we ignore the content of the reason and note only the fact that the reason has been given. So, 'I did X because I felt Y' now becomes nothing more than a single instance of a constructed, motivated reason.

During this process there emerged a further thematic concept – that of 'maturity'. It was observed that some stated reasons were very detailed whereas some points contained no reasoning whatsoever. Some comments related events in the past to the present or future, whereas some comments only made statements; some comments identified emotions and discussed explicitly the biases that these might contain, whereas others might only note the emotion; or some comments might relate activity to chains of events and then process, whereas some comments would only describe activities in isolation.

Putting these two concepts together, it seemed that the individual thematic elements mattered far less than how these were put to use to form a reason or justification. It was also simple to state – the greater the 'connectedness' of the individual elements, the more 'mature' the reason being provided. In general terms, a reason may either be simply stated or constructed in reflective text. No distinction can be made between these types of motivation and both are, in effect, constructed.

For example, a student might state 'I did X.' without supplying any motivation, reason or even any hints at this in the context. Similarly a student may have stated 'I did X because Y.' which represented a simple motivation, explicitly stated. Finally, there were those comments where there was considerable overlap of reasons and motivations across multiple theme elements. For example, 'I realised X, so I did Y because I previously did Z and it … etc.'

This notion of maturity also provided a way of approaching value – the definition of 'better', used in research question 2.

4.3 Method

To test the hypotheses, a small trial group study was conducted making use of the written reflection from the submitted assessment work of eight students in U101. Although this was a very small sample size, it was felt to be reasonable as a test sample because of the knowledge of the individual student work.

The reflective text from each student was extracted from two points during the course - the first and last assessments. This provided a differential to consider the second question. The text was analysed by the author and each reason identified and given a single number (1, 2 or 3) to represent the maturity (connectedness) of the reason presented as follows:

- 1 was given for a single stated element (e.g. 'I did X.')

- 2 was given for a simply connected element (e.g. 'I did X because Y.')
- 3 was given for complex, connected elements (e.g. 'I realised X, so I did Y because I previously did Z and it … etc.')

This coding process was repeated at a week interval to check the consistency of the coding themes and method. The first iteration found very little divergence of coding. This was repeated again after two further weeks and, again, little divergence (<5%) was found.

These numbers were then added to give a final maturity score for each student at two assessment points: the first and last main project TMA points in order to examine student development during the course. These scores were collated and then analysed to respond to the research questions. An additional open-ended analysis was performed to identify any other relevant patterns in the data.

4.4 Results

Responding to the first question, there is a reasonable, positive correlation (r=0.72) between student success and the number of reflection elements provided (Figure 3). That is, students with higher marks are also likely to have presented a higher number of reflection elements identified by the coding used. Similarly, students with lower marks are likely to have correspondingly low number of reflection elements.

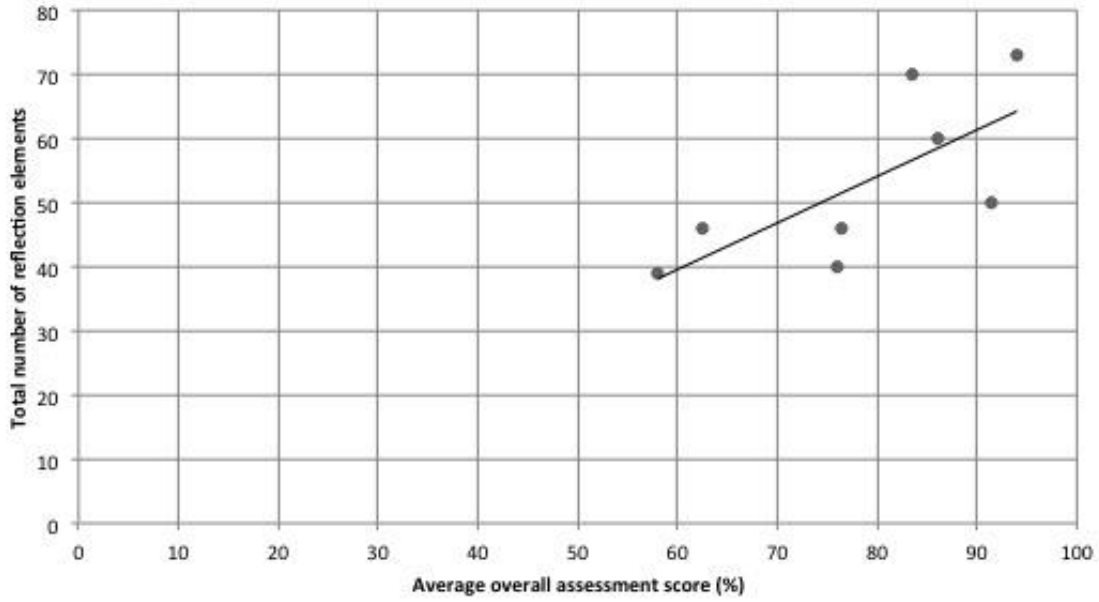

Figure 3 Correlation between student success and number of reflection elements presented

For the second question, there is a good, positive correlation (r=0.82) between student success and the reflection maturity score (Figure 4). That is, students with higher marks are also likely to have a higher reflection maturity score as measured by the coding used. Similarly, students with lower marks had lower reflection comment maturity scores.

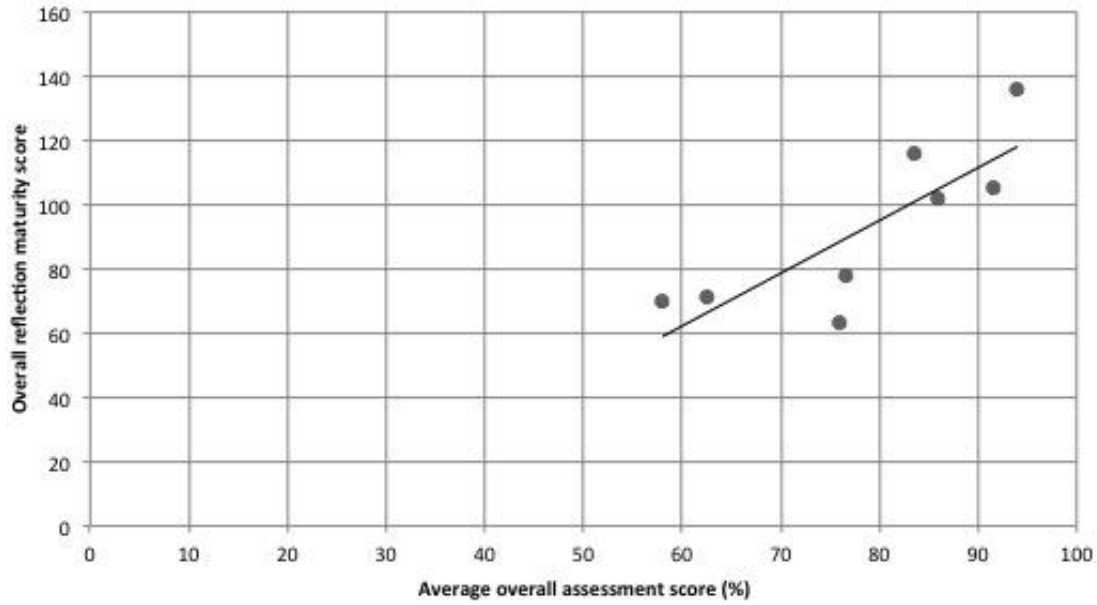

Figure 4 Correlation between student success and overall reflection maturity score

On the final question, there is a moderate, positive correlation (r=0.69) between student improvement and an increase in the number of reflection elements provided (Figure 5). That is, students with improving marks are also likely to have presented an increased number of reflection elements identified by the coding used.

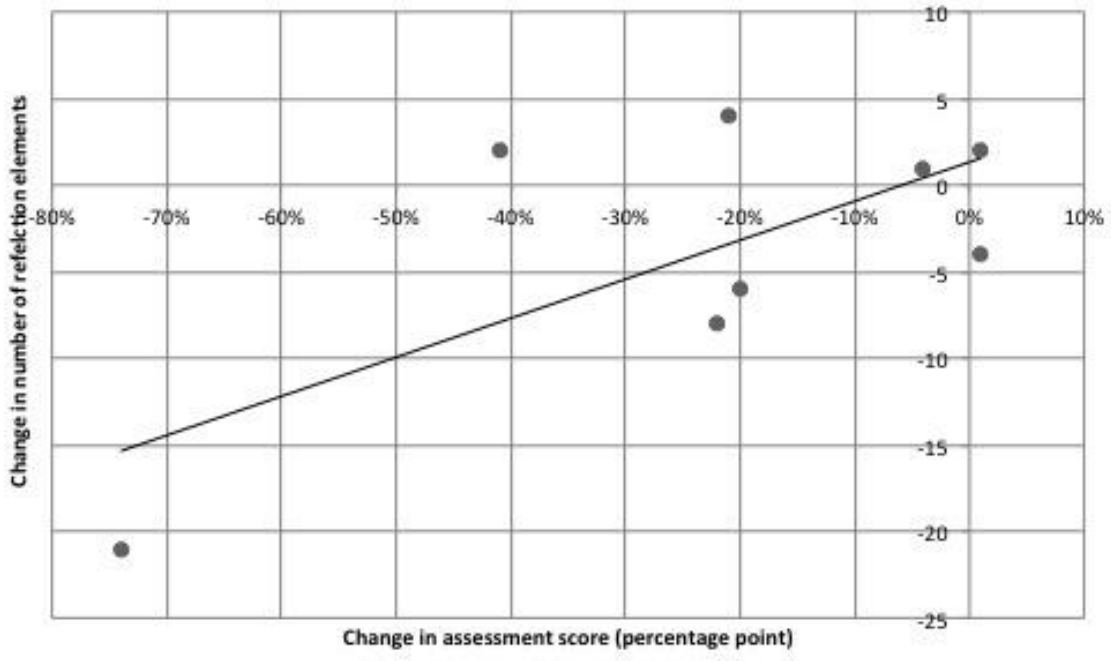

Figure 5 Correlation between changes in student score and number of reflection elements

There is a strong, positive correlation (r=0.92) between student improvement and the changing reflection maturity score of reasoning in the reflection comments (Figure 6). That is, students with improving marks are also likely to have an improving reflection maturity score as measured by the coding used. Similarly, students with decreasing marks had decreasing reflection comment maturity scores.

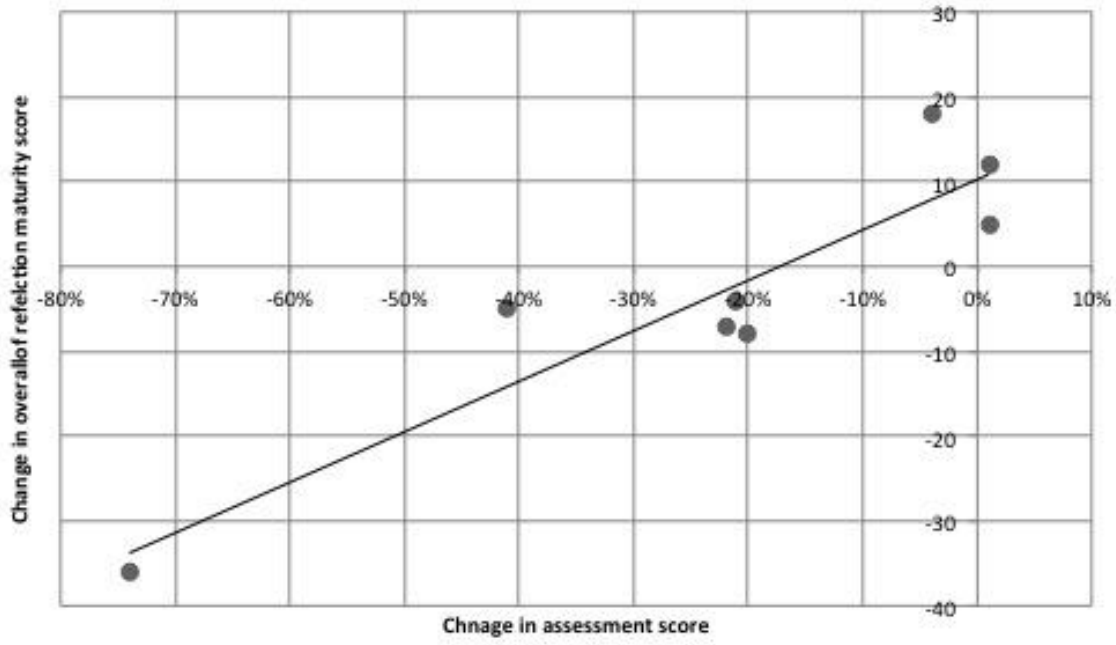

Figure 6 Correlation between changes in student score and overall reflection maturity score

5 Discussion

5.1 Reflection elements

The finding that the number of elements is linked to student success is perhaps unsurprising in many ways. The activity and assessment itself is designed to encourage and assess student reflection – so if students present reflection elements they will at least have a chance of a good result. But this is only a percentage of the overall assessment (typically, about 10-20%) so does not explain the result fully. Similarly, if this were the only criterion we would not see such a strong correlation between both number and quality (r=0.93) – that is, students who generate more reflection elements are also more likely to increase the connectedness of those comments. The volume of elements alone does not explain the results presented.

Similarly, the results could also represent what students learn to produce in reflection, especially since this is reinforced by assessment feedback and iteration. In many ways this is precisely what we might wish to see as design educators but the problems around reflective practice raised previously become a particular problem in education because they are amplified through iteration. Endlessly repeating the same actions in order to 'reflect-in-action' may cause tension when viewed by the framework presented here: that

the very value of the reflection is reduced because it is extrinsically constructed, not emergent from either process or value.

This perhaps explains why some reflective practice is seen as less 'something to be endured' (McCarthy, 2011) – it seeks only to meet assessment criteria or a behavioural formula rather than seeming to have value to the reflective individual. At its worst, the personal benefits of reflection might be kept private because they might not meet some inferred assessment criterion.

The reflection text in this study contained a high number of reflective elements that responded to prompts given in the assessments. But for a typical piece of text, the number of reflective elements provided by students far exceeded the prompt questions – even considering that a student may provide multiple elements to a single prompt. It is argued that the nature of reflective question prompts matters when designing learning and teaching that incorporated reflective practice. The framework and approach presented here may prove useful as an approximation for learning design validation.

5.2 Connections and connectedness

The grounded method used to establish the themes and coding provided an interesting framework and result in itself. At its simplest, the framework of elements and connectedness (maturity) presented is a useful way to conceptualise reflection in any guise.

For example, students presenting isolated reflective elements, such as statements of activity without reasons, are not really reflecting; they are simply describing. Many educators will recognise this as superficial or descriptive reflection and the results here confirm that there is good correlation between these types of element and poorer student success. But the results also show that this has potentially little to do with the truth of these statements – a simple behaviourist statement such as 'I sketched an option' is quite likely to be true but it is of very little value as reflection–of-action because there are no relationships to actually reflect on, only single subject statements. This also suggests lower utility as reflection-in-action for a very different reason. Our ability to construct reasons is innate, instinctive and pervades most human behaviour. In failing to construct such reasons, even for trivial events, it is clear that they have little or no perceived value – that is, they had little utility in the process. Simple reflective elements might be more 'truthful', but they are less valuable.

Conversely, the more complex reflection elements are those that have clearly had more utility during the process. This is evident in the statements themselves because they link to values, consequences, intentions, etc. But such reflections are far more likely to be less objectively truthful and more 'constructed' for all the reasons given. This is also matched in the results presented – complex, or mature, reflective elements might be less 'truthful', but they are more valuable.

5.3 Utility and value

The subjectivity in reflective text can be difficult to set assessment criteria for and having some means of guiding this process can be useful for both students and tutors. The findings here support the utility of explicitly setting out reflection activity and criteria for both students and tutors, something that is supported in much of the literature in reflection.

For example, explicit activities, such as Hickson's (2011) use of critical questions; Fook and Gradner's (2007) deconstruction/reconstruction model; Wetzstein and Hacker's process model (2004) incorporating conversational explanation; or simply Mewburn's (2011) talking cure.

Similarly, attitudes and approaches can also be explicitly used, such as Mlodinow's (2012) personal confrontation of bias examples; Engber's (2013) framework to consider storytelling and rhetoric; and, of course, the ever present issue of the 'Kruger and Dunning effect' (Kruger & Dunning, 1999).

In each case, it has to be stressed that the reflective practice has to be applied as much to the reflection itself as it is to the activity. The results here indicate that it is the utility and value of the process of reflection that matters most – not the output.

5.4 Limitations and other points

The study presented is a limited one, particularly in terms of sample size. Further work is required to repeat the findings presented here in larger numbers. In terms of replicability, this too requires further iteration and testing, in particular whether the model presented (elements and connectedness) can be applied consistently by other coders and verifiers.

But as a test of a refocusing of the elements of reflection it is argued to have some value in terms of bypassing assumptions around truth in reflection theory and considering the value of the process itself. This mediation between normative and relativist philosophies is also important in itself. One of the unique qualities that the practice of design allows is such a mediation that can in turn allow progress to be made in a difficult argument or philosophical position.

Some of the themes that emerged as measures of connectedness (or maturity) are also worth further study. Themes such as time; certainty; emotional awareness; and embodied thinking; all emerged repeatedly and, whilst these themes were not themselves used in the final model, the connectedness of concepts within them followed a common pattern. For example, a student might use time to: make no connections ('I did X'); connect two elements (e.g. 'I did X then Y'); or a student may generate complex relationships (e.g. 'I did X then Y because I had previously done Z'). These patterns of connection seem to appear across all themes and further investigation may yield some grammar of written reflection that may be of some value.

6 Conclusion

This paper has presented an alternative view of reflection as a process of utility in design education – one that seeks to leverage the personal value individual design students may derive from the practice. A framework for considering the elements and connectedness (maturity) of reflective writing was presented, demonstrating a correlation between these and student success.

In doing so, the ontology of reflection has been challenged in terms of it describing some objective reality. This challenge is needed to bring theories of reflection up to date with findings in other domains, especially psychology and cognitive neuroscience. It is argued that this provides a more sustainable method of reflection that is less to be endured and more to be incorporated into habits of valuable practice.

It is finally noted that these ideas should not be applied without question. Schön's model of professional reflective practice was readily adopted by design educators and has become a fixture of design pedagogy – and it did so because it has a perceived value. The philosophical underpinning was incomplete in many ways and it is only right to continue to develop and explore these ideas. The importance of such 'reflection-on-reflection' and the intra-disciplinary exchange of reflective practice findings is part of that value. Moreover, it should be one that design practitioners, students and educators are in a perfect position to take advantage of. As creative thinkers, designers may be more likely to construct reasons, so perhaps this should be a normal and explicit part of any design curriculum.

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