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Paper title: Double-loop reflective practice as an approach to understanding knowledge and experience.

John Gribbin*, Mersha Aftab, Robert Young, Sumin Park

Northumbria University
*Corresponding author e-mail: john.gribbin@northumbria.ac.uk

Abstract: The main aim of this paper is to consider the way in which reflective practice can assist practitioners in better understanding their individual knowledge and experience. Transitioning from a design novice to a design expert is described as a vague process, in which reflective practice can offer a level of understanding that provides an important insight into professional development within design. Through a comparison of two methods of reflection and analysis of reflective practice data, it is argued that repertory grid interviews have the potential to be a catalyst for double-loop learning within individuals; providing people with a platform to reflect on their beliefs and values in addition to their approach towards problem solving. This argument is based on the ability of repertory grids to uncover some of the implicit knowledge developed by designers, which is a distinct advantage to alternative methods of reflection and which is necessary to improve professional practice understanding and learning.

Keywords: Reflection, Design knowledge, Design experience, Repertory grids.

1. Introduction

Within design practice, reflection is critically important in translating experience into the development of new skills, attitudes, knowledge and capabilities. This is epitomised by Schön (1991), who argues that experience alone does not necessarily lead to learning and that a deliberate reflection on action is necessary in order to fully understand one's experiences. The resulting experience, knowledge and intuition become critical in a designer's attempt to solve complex problems and navigate a design space when creating innovative solutions. Experienced designers have the capability to apply their knowledge to any given context and this paper will consider the way in which reflective practice can

support this, by allowing practitioners to become more aware of their knowledge and experiences.

Within the leadership function of organisations, Aftab (2013) identifies that designers can typically be categorised into thinkers and practitioners. Design thinkers are those who work with strategies and solutions to problems facing organisations in the distant future (over twenty years) and consequently have an involvement in the formulation of the future of the company. Contrastingly, practitioners are those who work to create scenarios that are applicable in the present, in terms of relevant products and services. In doing this, they follow the direction provided by the thinker in order to achieve the goals identified for the future. Both of these roles require a variety of tacit, implicit and explicit knowledge, however this paper argues that propositional and non-propositional knowledge stand out as a key differentiator between the two roles.

The authors of the current paper take the viewpoint of outside researchers looking into organisational innovation practices, as opposed to that of a reflective practitioner reflecting upon their own actions. It also follows the belief that not all knowledge can be explicated, however it is the role of researchers to uncover and document as much of this knowledge as possible. This is a viewpoint underpinned by Polanyi (1958), who argues that not all types of knowledge can be understood; instead some types of knowledge such as the arts have limited capability for transfer; they cannot be transferred by prescription, since no prescription for it exists. Subsequently the only way for this type of knowledge to be transferred is from person to person, such as from an expert to a novice. As a result, it is only possible to explicate a finite amount of knowledge in any given situation.

The intention of the paper is to consider methods that will translate as much of the implicit skills and knowledge of the design practice process as possible, which merges into tacit elements. The paper will begin with a discussion of knowledge in relation to design professionals, before considering the relationship that knowledge has with experience.

2. Knowledge within design

2.1 Thinkers and practitioners

The articulation of design knowledge entails defining what designers ‘knowingly-think’ (explicit knowledge), ‘knowingly do’ (implicit skills) and ‘unknowingly do’ (tacit knowledge). In reality, most knowledge in design practice has been claimed to be either tacit or implicit (Cross, 1984), or a combination of both (Smith, 2001). Furthermore, Young (2008) confirmed that certain forms of implicit knowledge can be made explicit such as ‘craftsmanship and its strategy’ in the form of a design outcome, but this is not likely the case for other forms of tacit knowledge, which are both hard to understand as well as difficult to articulate explicitly.

Polanyi (1958) and Wilson (1999) provide two different and rather contradictory views on knowledge. Whilst Polanyi believes that certain types of knowledge will always remain tacit

and inbuilt in human intellect, Wilson provides the concept of consilience, which maintains that in future all branches of knowledge will be known, made orderly and organised. Arguably, design knowledge poses a challenge to Wilson's notion of consilience, as knowledge in design has been a contentious matter, which is made worse because of the conflict between design theory and its practice. The evidence collected during an investigation with multinational organisations (Aftab 2013) also confirmed this conflict; where the thinkers and the practitioners within the innovation team were divided in their knowledge, way of working and priorities. Thinkers in the organisation proved to have a strong foundation of propositional knowledge (Gemma 2014), based on an awareness of 'how' an innovation process should work to overcome future challenges. Contrastingly, the practitioners held the working knowledge of 'what' needs to be done to make innovation happen on a day-to-day basis; more closely aligning practitioners with a foundation of procedural knowledge (Niedderer 2007).

Both thinkers and practitioners hold two very important types of knowledge, i.e. explicit knowledge and implicit skills. Nevertheless, there was one peculiar knowledge type that existed in both the groups, and was very difficult to articulate i.e. tacit knowledge. Casakin (2007), Cross (2008), Pugh (1990) have all identified where tacit knowledge resides within design activities, but the ways in which this knowledge could or can be made explicit and recognised by the practitioner is still inchoate.

2.2 Articulating knowledge and experience in design innovation practice

Aftab (2013) confirms that the explicit definition of certain aspects of design knowledge, such as process, methods, and tools for design, is essential in order for design to gain and maintain a functional leadership role within an organisation. This involves making sure that every individual working within the innovation process (whether a thinker or a practitioner) is aware of what they are doing, to improve their design performance in problem solving; a process that Schön (1987) named as *knowing-in-action.* Schön described, *Reflection-in-action* as having a critical function, questioning the assumption structure of *knowing-in-action*, more commonly also known as critique (Evans, Powell, and Talbot, 1982). Schön (1987, pp.39) explained that individuals reflect on their way of thinking which places them into a particular situation; and through this process of reflection these individuals may reorganise strategies of their action, understanding the experience, or techniques of problem framing.

It is important to note here that knowledge appears to develop through experience within design practice, where experiential knowledge becomes an important factor underpinning the decisions made by practitioners. Novices tend to solve problems by attempting to represent and classify the problems by their surface features, whereas experts represent them in terms of their underlying features (Chi, Feltovich et al. 1981). Robinson (2010) highlights that experts are at a great advantage in solving complex problems, in that they

have a richer store of relevant knowledge and an ability to conceptualise it in ways that enable them to perceive possible problem solutions. Voss (1989) further emphasises this view, indicating that good problem solving emerges from a person having a substantial knowledge base integrated with knowing how to apply that knowledge to a wide range of problem contexts. This suggests that as designers gain more experience, their overall competence in terms of solving complex problems also increases. Their exposure to a variety of problem situations provides a solid basis from which they are able to draw experience and tailor their abilities towards the new problems that they face. The next section will further consider the role of experience within the development of design professionals.

3. Experience within design

Lawson and Dorst (2009, p.216) argue that expertise within design is not acquired in a continuous seamless manner, instead it is suggested that there appear to be more or less distinct layers of expertise that allow different modes of thinking and action. It is widely believed that experts differ from novices in that experts are aware of a greater number of concepts, organise information on the basis of identifying principles and are capable of applying concepts in a flexible fashion contingent on the key characteristics of a situation (Mumford, Marks et al. 2000). Transitioning from novice to expert is of core importance when considering the journey of a design professional, however there is much debate surrounding the distinction of individual experience levels that occur on this journey. Heskett (2002) writes about this process as layering, where new developments through experience are added over time to what already exists. In this context, layering is a useful term to describe the process by which design knowledge is formed by integrating 'designerly' approaches to identify the richness of design activity. The journey from novice to expert is documented in the rest of this section and is summarised in Appendix 2.

Perhaps the most extensively utilised model of skill acquisition is provided by Dreyfus and Dreyfus (1986, 2002), who suggest that there are five stages in the human skill acquisition process with an individual transitioning from novice to expert with increasing exposure to skilful practice. The first stage of novice occurs when a person is provided with rules for determining actions within a given situation, which they will follow rigidly until they reach the desired outcome. The learner then transitions to advanced beginner when they have gained experience working within real situations and learned that the rules don't necessarily apply to all situations. Furthermore, this is the stage in which experience becomes more important than any form of verbal description. Upon gaining a certain amount of experience, people then enter the competency phase, in which the number of recognisable context-free and situational elements present in a real-world circumstance eventually become overwhelming. People learn a hierarchal procedure of decision making in order to solve these problems, by choosing a plan to organise a situation and examining the most important factors to that plan.

When people enter the two highest levels of skill, their approach to problem solving is characterised by a rapid, fluid, involved kind of behaviour that contrasts to the problem solving approaches used within the lower levels. Proficient learners are capable of considering the rules to a situation, before making conscious choices of both goals and decisions after reflecting upon a range of alternatives. Proficiency is only developed if experience is assimilated in a way in which intuitive behaviour replaces reasoned responses (Dreyfus 2002). The expert performer differs from the proficient performer in that the expert is capable of seeing what needs to be achieved and sees how to achieve their goal. With enough experience, the expert is capable of providing an immediate intuitive situational response to a problem, due to their experience in a variety of different situations.

Within design practice, Lawson and Dorst (2009) criticise the use of the Dreyfus framework in that design is not just limited to people who are formally trained in the subject. This leaves questions surrounding a framework that begins at the novice level, given that people are capable of designing without even realising that they are doing so. Despite this, Lawson and Dorst (*ibid*.) argue that the Dreyfus framework provides a strong foundation to encourage thinking about the development of expertise in design. Dorst (in: Poggenpohl and Satō 2009) takes measures to build on the Dreyfus framework in a way that addresses his earlier critique; suggesting that a 'naïve' level should be added in order to precede the novice stage of skill. The 'naïve' state of designing is adequate for explaining the design-like tasks that non-designers carry out in their day to day life, in which people have unsystematically gathered experience. Furthermore, Dorst (*ibid*.) proposes an additional level of experience, superseding mastery, in the form of a 'visionary', in which a person becomes so interested in developing new ideas that the normal level of expected professional competence becomes less important. The work of such designers may often not be realised but it is deemed necessary as visionaries are explicitly redefining the design field that they are working in. This is echoed by Sennett (2008), who refers to craftsmen in society who are capable of utilising their mastery in order to change the methods and tools of their craft in order to contend with the evolving nature of the problems and contexts that they are working within.

Ultimately, this leads to a refined framework of experience that could be mapped against a range of design career paths, however there are still questions that need to be answered in order for these types of frameworks to comprehensively explain the way in which individual designers develop mastery of their subject. The existing framework is particularly oriented around the skills of a designer, when arguably other factors must also be considered to provide a comprehensive explanation of a designer's expertise. Aspects such as knowledge and attitude also play an important role in design problem solving and should be reflected in future frameworks. Furthermore, it can also be difficult to recognise when people are transitioning from one level to the next. Dorst (in: Poggenpohl and Satō 2009) argues that in order for people to progress they must first acquire sufficient knowledge within a particular level. Next they must undergo a mental realisation that their newly acquired knowledge and

skills can be utilised in a new and different way. This paper argues that reflection is capable of being a catalyst for this process, as the leap from one level of experience to the next can be a difficult transition for individual learners.

4. Reflection and double-loop learning

Schön (1991) argues that within the context of design, experience alone does not necessarily lead to learning and that a deliberate reflection on action is necessary. In order for people to translate their tacit understanding and implicit skills and experiences into learning and explicit knowledge, they must engage with the process of reflection in order to articulate this value. Being able to reflect upon experience in this way can help individual learners to align their individual competencies within a given framework of expertise and form a better understanding of their development as a design professional.

Schön and Argyris (1974) highlight two different learning strategies that involve experience-based learning and can be driven by the process of reflection and is visualised within figure 1. The first strategy is single-loop learning that involves the creation and adoption of new action strategies in order to understand inner values. This often takes the form of problem solving with individuals attempting to improve the systems they operate within. Contrastingly, double-loop learning occurs when people focus on the improvement of their inner values as opposed to merely understanding them. People begin to question the underlying assumptions behind their techniques, goals and values in order to understand why they do what they do, as emphasised by Cartwright (2002, p.68) who indicates that 'double-loop learning is an educational concept and process that involves teaching people to think more deeply about their own assumptions and beliefs'. Within the context of these two strategies, the purpose of reflective practice is to allow individuals to describe a world that more faithfully reflects the values and beliefs of the people in it (Greenwood 1998).

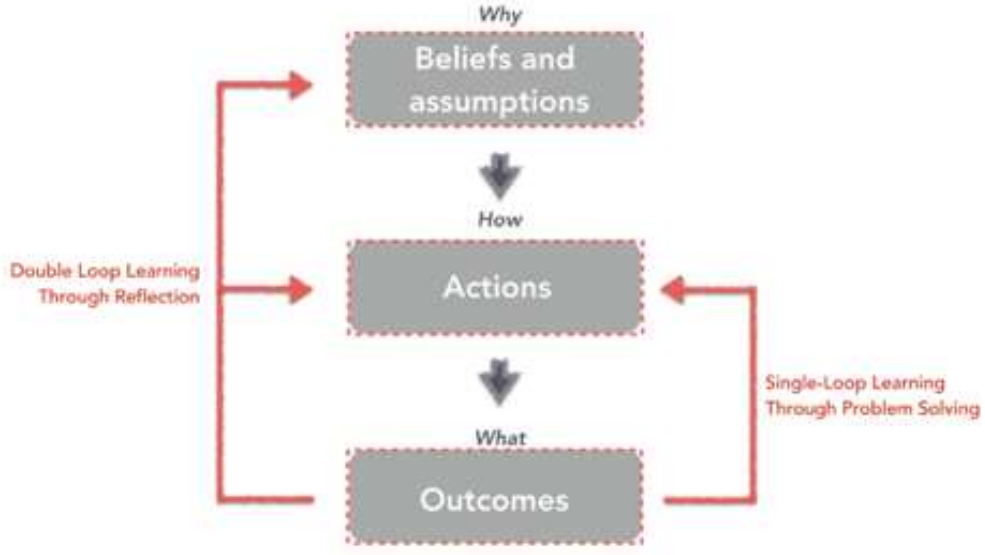

Figure 1: Single and double-loop learning.

According to Argyris (1976), double-loop learning is focused upon improving the problem solving capabilities of people who are involved in solving complex and ill-structured problems, which are capable of evolving as problem solving advances. This makes double-loop learning especially desirable within the context of design-led organisations, where both thinkers and practitioners are typically expected to solve problems that operate within these boundaries (Rittel and Webber 1973, Stacey, et al. 2000, Coyne 2005, Dorst 2011). Furthermore, this style of learning is pertinent within cultures that embrace failure and view it as an important tool for learning (Liepė and Sakalas 2015). This is an approach typically favoured by organisations seeking to engage with radical innovation by following design-led innovation practices (Verganti 2009). In this situation, organisations that learn how to fail intelligently consistently outperform those that seek to minimise the frequency of failure (Schrage 1989, Sudheim 2013).

Double-loop learning can therefore be used to help both organisations and practitioners better understand the underlying beliefs and assumptions that govern their actions. In the case of organisations, this can benefit innovation practices, by improving performance when solving wicked problems that present themselves. With regards to individual practitioners, double-loop learning can provide individuals with a more holistic learning experience, ensuring that individuals are better aware of their professional experiences, which is of great importance within practice-led professional learning. With these benefits in mind, the next section will discuss the methodology that the paper adopts in considering which methods are most appropriate in facilitating double-loop learning.

5. Methodology

This paper follows the approach of grounded theory, combined with case study analysis in order to investigate methods that are capable of facilitating reflection. Grounded theory was initially proposed by Glaser and Strauss (1967) as a 'systematic generating of theory from data that itself is systematically obtained from social research' (Glaser, 1978 in: Hussein, et al. 2014). It is an inductive method of generating theory through the simultaneous collection and analysis of data, with the goal of generating relevant and significant knowledge through social research. Grounded theory has limitations in that researchers can often blur methodological lines by selecting purposeful instead of theoretical sampling (Charmaz 1990), which must be controlled by sampling based on emerging theory. Within this paper, the goal of grounded theory was to derive fresh insights into existing case studies and as such, the sampling was guided by the selection of relevant cases.

Yin (2014) identifies case studies of empirical enquiry that investigate a contemporary phenomenon in depth and within its real-world context; particularly when the boundaries between phenomenon and context may not be clearly evident. Similar to grounded theory, cases provide an opportunity to explore propositions and generate theory from the resulting data. Grounded theory is often limited in terms of its generalisability with theories often only relevant to the context in which they are derived (Stebbins 2001). Combining it with

case study research appears to mitigate the effects of this issue, as the use of multiple cases begins to provide examples derived from multiple experiments that investigate phenomena under different conditions (Lipset, et al. 1956, Hammersley, Foster et al. 2000, Johansson 2003).

Eisenhardt (1989) highlights that case studies typically combine multiple methods, which may be qualitative or quantitative in nature. Within this study the primary data collected was qualitative and collected through workshops that occurred within the setting of design education. The workshops aimed to encourage reflection in twelve multidisciplinary postgraduate students, with the aim of explicating some of the knowledge and skills that were developed over the course of three different design focused projects. The projects in question were all client driven, with the first focusing on stakeholder engagement for a non-profit organisation. The second project aimed to analyse the structure of an organisation through an evaluation of membership platforms available to their clients; whilst the final project was brand driven, offering a fresh perspective on potential avenues of future business development as well as alternative methods of improving customer experience.

6. Analysis of methods

6.1 Introduction

The previous sections of this paper have discussed the importance of reflective practice to both organisational learning and individual design professionals. This section will build on this discussion by outlining the methods that are available to individual design practitioners in order to facilitate reflective practice with the goal of creating double-loop learning. Primarily, an objective researcher has facilitated these methods and assisted in the interpretation of findings in order to maximise the value gained by the reflective practitioner.

6.2 An overview of reflective methods

Reflective practice is common across a wide range of disciplines, with a variety of methods being utilised to facilitate the process. In order to analyse some of these methods in more detail, Appendix 1 provides an in depth overview; outlining a definition of each method alongside any advantages and disadvantages noted by other studies, as well as highlighting any studies that utilise the method to facilitate reflection.

Due to the scope of the paper, it is impossible to further discuss each method of reflection individually; therefore the remainder of the paper will discuss methods that appear to be most relevant in facilitating double-loop learning within design practitioners. Whilst all of the mentioned methods are effective when it comes to facilitating reflection, not all of the methods are capable of eliciting implicit knowledge and skill leading to the tacit dimension, which reduces their appropriateness for this work.

6.3 The repertory grid technique

Although workshops facilitated with interviews and observations proved to be a useful tool in understanding the explicit knowledge that is held by practitioners, they only offered a small insight into the implicit elements that contribute to professional practice. As a result, it is important to consider methods of reflection that are capable of beginning to uncover some of this knowledge. Appendix 1 shows that repertory grid interviews fit these criteria. Subsequently this section will consider the merits of the approach as a reflective method.

A repertory grid is a method for eliciting personal constructs in relation to a given topic. The method was derived by Kelly (1955), who expressed that people are continually engaged in the process of devising new theories, testing hypotheses based on these theories and acting on their findings (Giles 2002). Kelly (1955) described this process as personal construct theory, arguing that individuals construct rational worlds based on their experiences, which shape a pattern that can be defined as 'personal constructs'. Candy (1990) describes a system of personal constructs as a repository of what a person has learned, a statement of their intent and the values by which they live. As a person builds up their construction of reality, more and more constructs are derived until eventually a complex and unique picture of one's reality is formed; thus demonstrating the way in which a person organises their social world, which is then open to interpretation.

Repertory grids are often utilised in order to facilitate the articulation of various personal constructs. A repertory grid takes the form of a table or matrix that can contain either quantitative or qualitative data. Tables consist of columns of elements, which define the area of study and rows of constructs, which are themes that link various elements together (Giles 2002). Constructs within the grid are always bipolar, meaning that they comprise two opposing values, which helps to ensure that they can be distinguished from other concepts. This process is perhaps best described by Persson (2009, p.254), who expresses it within the context of an interview situation:

"If Anne is interviewed and the topic is [her] friends she might say that Mary and John are nice and Sally is not. This is the elicitation of one pole of a construct but it would not be complete without the other pole. Anne will now describe the attribute that Sally has that is contrasting to nice. If she says that Sally is unpleasant compared to the other two, the two poles of the construct [are] nice and unpleasant. Anne will then rank all the elements, her friends, according to a scale. The procedure continues until it is no longer possible for Anne to elicit more constructs."

When conducting a repertory grid interview, the facilitator can ask questions in a way that target both emergent and implicit constructs (Fransella, Bell et al. 2004). Emergent polls can be derived by asking a person to explain the way in which two elements of a triad are in some important way similar and thus different from the third element. In order to uncover

implicit constructs, the facilitator can then ask how the third element is different from the two that were stated to be similar. Björklund (2008) suggests that eliciting constructs in this way allows researchers to understand the implicit learning that occurs through the progression of a professional craftsman from novice to expert. The repertory grid technique can elicit implicit constructs and patterns that would not be possible to elicit through regular ordinary interview techniques as the information is not stored in verbal form. Therefore, asking participants to consider implicit constructs in this way begins to uncover some of the tacit knowledge that they possess.

One of the biggest advantages of the repertory grid technique is that it can be used in facilitating double-loop learning for individual practitioners. The aim of personal construct theory is to document a person's reality with regards to individual situations, which can be directly utilised when understanding the beliefs and assumptions that underpin their decisions within a particular context (Kelly 1955). Furthermore, the technique can provide an insight into the tacit knowledge held by practitioners (Jankowicz 2004), which is hugely beneficial in the design profession where both thinkers and practitioners need to become more aware of the tacit factors that contribute to their overall expertise.

As a research method, repertory grids are particularly useful in understanding the views of others without misinterpretation from an outside source (e.g. a researcher). It is easy to talk to a person and believe that we have understood them, however unless their personal constructs are well understood there is a risk that our own thinking will simply be transferred to the situation (Jankowicz 2004). By highlighting as many personal constructs as possible and ensuring that the person reflecting spends time developing bipolar constructs, there is minimal interruption from the facilitator leading to a specific insight into a situation, thus reducing the potential for bias as a research method.

Authors such as Tofan *et al*, (2011) and Anderson (1990) find that when using the repertory grid technique within different situations, one of the main disadvantages is the time that it takes to implement the method particularly in relation to alternative psychometric tests. Equally, Tofan (*ibid*.) highlights that participants can find it difficult to interpret the data that they create when reflecting through this method. Subsequently, the implementation of the method as a tool for reflective practice would have to be carefully facilitated in order to guide participants in both creating and interpreting their own grids. Despite this drawback, the repertory grid technique appears to be one of the most useful techniques for encouraging reflection and double-loop learning within design thinkers and practitioners. They are a viable tool in uncovering the personal constructs of individuals, which provides an insight into the tacit and explicit knowledge and experience that they have acquired in their practice. As a result it is possible that the repertory grid can be utilised in order to help thinkers and practitioners better understand their experience in relation to a given framework of expertise.

6.4 A reflection on the repertory grid process

One of the primary aims of the pilot study was to explore whether it was possible to implement the repertory grid technique in a workshop setting, rather than through individual interviews. The success of the method under these circumstances would have allowed a researcher to provide a greater ownership of the method to the participants, resulting in a method capable of facilitating double-loop learning without an independent researcher having to guide the process. From this, it would have been possible to utilise the method in a greater range of circumstances, as it would be less resource intensive to implement it. However, the data provided by the students in the workshop setting was consistent with the approach of single-loop learning, with a large focus on the methods that were used throughout the projects and little comparison of the deeper beliefs and assumptions that underpinned decisions. Within a one on one interview process, it is possible for a researcher to overcome this issue by using a process of laddering, in which constructs of a higher order of abstraction can be elicited (Fransella, Bell et al. 2004). Laddering involves the elicitation of constructs through triadic comparisons, before asking a person to say by which pole of each construct they would prefer to be described. From this they are asked to consider why they prefer that particular construct and the advantages to that construct as they see them (Hinkle 1965). This process allows the students to consider the system through which they are working in much greater focus.

The results of the workshop also provided an interesting insight into the attitudes of the students taking part in the projects. Through conducting a correlation analysis on the numerical ratings that students gave to each individual construct, it was possible to determine which aspects of the projects were statistically related. This highlighted the aspects of each project that students found engaging and which they found frustrating. This is of importance to researchers investigating a growing body of research surrounding design attitude (Boland and Collopy 2004, Michlewski 2006, Nelson and Stolterman 2012). This type of study frequently investigates the factors that designers and people from a broader range of disciplines find engaging and frustrating when collaborating across innovation projects; which is essential when trying to derive a picture of the culture of an organisation.

Furthermore, the students themselves responded positively to the method when asked how they felt about the process. They particularly felt that the comparison between projects made through repertory grid gave it a distinct advantage over the other methods of reflection that they had previously utilised. Through the comparison of different projects, they were made to think differently about the skills and knowledge that they had developed over multiple projects and were given the opportunity to consider how these aspects of their competency had been developed over time. Perhaps most importantly, the students appeared engaged throughout the entire process, as it is critical that a method of reflection has this effect as if the opposite is true it is unlikely that people will fully engage and that any double-loop learning will occur.

7. Conclusion

7.1 Summary

The main aim of this paper was to consider the way in which reflective practice could assist practitioners in better understanding their experiences, in order to improve their overall practice. Design knowledge is often referred to as being episodic, in that it is derived through our experiences (Lawson and Dorst 2009). Authors such as Chi *et al*. (1981), Robinson (2010) and Voss (1989) all highlight that knowledge develops with experience of design practice; resulting in experts being able to problem solve more effectively than others who may be less experienced. Despite this, Dorst (in: Poggenpohl and Satō 2009) indicates that we are still unaware of the way in which a professional might increase their considered level of expertise. Transitioning from novice to expert can be a vague process, however there are clear distinctions as to the steps that occur along the way. It is argued that reflective practice can help practitioners to understand their own experience and knowledge, in turn assisting them as their expertise develops over their careers.

The paper adopted a methodology of grounded theory and case study analysis to consider a range of reflective methods that could give practitioners a better insight into their experience. Through workshops, it was determined that design professionals appear to develop the specialist knowledge associated with the role of thinkers or practitioners when they begin their career within an organisation (Aftab, 2013). Furthermore, in certain situations, effective reflective methods need to allow a person to reflect on the influence of others as well as themselves in the decision making process. From the methods analysis, it appears that the repertory grid technique has the potential to be a suitable method for enabling double-loop learning within design professionals, with its ability to uncover tacit knowledge being a particularly strong advantage over the alternative reviewed methods.

Repertory grid has the potential to be utilised as an independent form of enquiry, however for best results it should perhaps be combined with a form of reflective or reflexive conversation. The current study utilised workshops as a way of facilitating these conversations, engaging with multiple practitioners at the same time in order to efficiently collect data. Repertory grid also needs to be facilitated by an objective researcher in order to guide the process and encourage the participant to reflect on appropriate incidents. Further research should look to implement this approach and document the findings in relation to mapping out the experience of design practitioners.

7.2 Implications for future work

An argument has been constructed, through a limited empirical study, in favour of the use of repertory grids as an effective method to create double-loop learning in design practice. It appears to be the most effective method of reflection that is capable of uncovering tacit knowledge within practitioners whilst allowing people to reflect deeply on their beliefs and assumptions as well as their actions in a given situation. To further this work, studies should

seek to implement the repertory grid approach across design professionals from a range of experience levels in order to ascertain relationships; between levels of experience and breadths and depths of explicit, implicit and tacit knowledge and whether and how these might reinforce double-loop learning to support the growth of professional knowledge. Such studies would further validate the method's appropriateness in helping individual designers to better understand their design practice and as a result help to improve their overall performance. Also, they would help reduce the vagueness of the process of designers transitioning from a novice to an expert practitioner and how this relates to descriptions of competence in organisations.

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Appendix 1

Reflective processes & methods	Description	Studies	Advantages	Disadvantages
Critical incident analysis	A set of procedures for collecting observations of human behaviour in such a way as to facilitate their potential usefulness in solving practical problems and developing broad psychological principles' (Flanagan, 1954, p.1).	Butterfield et al, 2005; Tripp, 2011; Cope and Watts, 2000; Hughes et al, 2007	Data is collected directly from the participants in their own words. Flexible method for participants to engage with. Highlights key points for personal change/development.	Critical events may not be recognised at the time. People might not recognise the importance of an event within a wider social context. Biased towards events that are considered recent.
Reflective journals	Reflective practice journals give space for regular, frequent, private, explorative and expressive writing (Bolton, 2014).	Uline, 2004; Francis, 1995; Pyhtila, 2014; Al-karasneh, 2014; Phani, 2012; Paton, 2012	Can make different connections between different situations. The writer can share aspects of the journal at their own discretion.	Not everyone prefers to communicate through writing or drawing. May be largely descriptive with little analysis. Difficult to uncover tacit knowledge.
Repertory grids	An interview technique utilised in order to elicit personal constructs and individual beliefs.	Kearns et al, 2003; Anderson, 1990; Hassenzahl, 2000; Korthagen, 1993; Solas, 1992; Hill et al, 2015; Young, 1989	Can be difficult to implement. Elicitation of personal constructs needs to be handled in a sensitive manner. Can be used to explicate tacit knowledge.	The interviewer can access the participants views of their own worlds. Can offer insights into a rich source of data. Construct elicitation comes entirely from the participant, minimal researcher intervention.
Reflective and reflexive conversations	Conversations in which the facilitator asks a series of questions designed to encourage reflection in participants.	Goodfellow, 2000; Moore et al, 2001; Gray, 2007; Black et al, 2000	Can help the process of reflection in action and the search for new perspectives of a situation.	Need to critique assumptions that are made through the process (Palmer and Dumford, 1996).

Appendix 2

The following table collates definitions of the seven levels of experience within design, with definitions taken from: Dreyfus and Dreyfus (1986), Dorst (in: Poggenpohl and Satō 2009) and Lawson and Dorst (2009).

Stage of Expertise	Description
NAIVE	*The Naive state of experience is adequate for explaining the design-like tasks that non-designers carry out in their day to day lives, in which they have unsystematically gained experience in the discipline. This is primarily derived through people engaging with problem solving in a designerly, yet uninformed way.*
NOVICE	*A novice will consider the objective features of a situation, as they are given by the experts, and will follow strict rules to deal with the problem.*
ADVANCED BEGINNER	*For an advanced beginner the situational aspects are important, there is some sensitivity to exceptions to the 'hard' rules of the novice. Maxims are used for guidance through the problem situation.*
COMPETENT	*A competent problem solver works in a radically different way. Elements in a situation are selected for special attention because of their relevance. A plan is developed to achieve the goals. This selection and choice can only be made on the basis of a much higher involvement in the problem situation than displayed by a novice or an advanced beginner. Problem solving at this level involves the seeking of opportunities. The process takes on a trial-and-error character, with some learning and reflection. A problem solver that goes on to be proficient immediately sees the most important issues and appropriate plan, and then reasons out what to do.*
EXPERT	*The expert responds to a specific situation intuitively, and performs the appropriate action straightaway. There is no problem solving and reasoning that can be distinguished at this level of working. This is a very comfortable level to be functioning on, and a lot of professionals do not progress beyond this point.*
MASTER	*The master sees the standard ways of working that experienced professionals use not as natural but as contingent. A master displays a deeper involvement into the professional field as a whole, dwelling on successes and failures. This attitude requires an acute sense of context, and openness to subtle cues.*
VISIONARY	*The visionary consciously strives to extend the domain of operation developing new ways of doing things, outcomes, definitions of the issues, opens new worlds and creates new domains. The visionary operates more on the margins of a domain, paying attention to other domains as well, and to anomalies and marginal practices that hold promises of a new vision of the domain.*

About the Authors:

John Gribbin is a current doctoral student at Northumbria University. John's work focuses on identifying the skills, knowledge, attitudes and capabilities of designers across postgraduate education and organisational innovation practices in order to improve understanding of complex innovation processes.

Mersha Aftab is a Senior Lecturer in Innovation at Northumbria University. Mersha's work has led her to collaborate with Philips, Nokia, Daimler, Sony Erricson, Lego, Google and Samsung. Mersha's interest lies in exploring the role of design in triggering a change in the organisational culture.

Robert (Bob) Young is a Professor of Design Practice in the Faculty of Arts, Design and Social Sciences within Northumbria University and head of its Design Innovation Practices research community. His specific interests are in design-led innovation, service design and social innovation.

Sumin Park is an interior Designer in South Korea with over 14 years experience working in this field, leading design teams to deliver interior schemes. As a postgraduate student, Sumin has tried to accurately define the roles and responsibilities of Designers within organisations.