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A Conceptual Approach to Exploring Creativity in Requirements Engineering

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Abstract:

Requirements engineering (RE), an early phase in software development, is the process of discovery, analysis, modelling and specification of user and business requirements for information systems. The lack of creativity theories and models within RE has been gaining increasing recognition within the RE community. This paper synthesises concepts from creativity research and RE creativity research to build a theoretical foundation for the study of creativity in RE. We argue that creativity in RE goes beyond technical aspects and involves different levels, loci, and inter-related elements including product, process, domain, people and socio-organisational context. Different facets of creativity need to be integrated within RE approaches and methods to effectively foster and support creativity in this field.

Keywords

Creativity, requirements engineering, problem solving, creative process, creative product

INTRODUCTION

The process of discovering, analysing, modelling and specifying business and user requirements for an information system is known as requirements engineering (RE). Creativity has emerged as a new research area within RE in recent years with two main motivations. First, the emergence and advancement of new information and communication technologies (ICT), such as the Internet and mobile and ubiquitous computing, create new forms of organizations and dramatically change the way people live and work. Organisations and people eagerly seek innovative ways, through smart use of ICT, to maximize potential benefits of ICT and create added value to business. Creative thinking in RE is crucial in creating new visions and discovering requirements for future business information systems (2005; Hoffmann *et al.*, 2005). Second, recent research has highlighted the highly creative and insight-driven nature of the RE process (Nguyen et al., 2000; Nguyen and Swatman, 2003). Nguyen et al. (2000) described the creative RE process as consisting of structured building up and insight-driven restructuring of the requirements model. Other authors utilised creativity techniques to support creative thinking during the RE process (Maiden and Robertson, 2005).

While creativity has been recognised as important in RE, research into creativity in RE has been described as being at the early stage of theoretical development. Nguyen and Swatman (2003) pointed out a need for aligning RE creativity and creativity in other disciplines especially in the psychology of problem solving. Maiden and Robertson (2005) noted a lack of creativity theories and models in current RE research and practice. To advance creativity knowledge in RE, we integrate two bodies of knowledge: general creativity research and RE creativity research. In this conceptual paper, we discuss and relate different facets of elements from creativity research to RE in order to build a theoretical foundation to study creativity in RE. The paper is structured as follow. First we describe an overall framework consisting of different levels, loci and elements of creativity. Next, we discuss five creativity elements, product, process, domain, people and context, and relate them to RE. Finally, we suggest implications for RE research.

OVERVIEW OF THE FRAMEWORK

Creativity Levels

Boden (1991) differentiated two levels of creativity - psychological or P-creative ideas and historical or H-creative ideas. According to Boden, P-creativity can be examined at an individual level while H-creativity requires a broader historical and cross-cultural analysis. In RE, creativity occurs at different intermediate levels in the continuum between P- and H- levels and is a result of collective effort and subject to collective judgment of a team, organization, domain community, or society. We adopt S-(situated) creativity, a notion introduced by

Sosa and Gero (2003), to describe creativity levels in RE. According to Sosa and Gero, creative solutions are produced to satisfy the needs of a specific social group (e.g. an organisation), therefore, *"the socio-environmental conditions within which the design practitioners produce such (creative) solutions equally define, constrain, and facilitate their creative practice"*. Creativity in RE occurs at an appropriate S-level, and subsequently a P-level, but not necessarily an H-level.

Creativity Elements

Five elements including Product, Process, People, Domain, and Socio-organisational Context form major topics of discussion in the creativity literature. Plucker (2003) defined creativity as *"the interplay between ability and process by which an individual or group produces an outcome or product that is both novel and useful as defined within some social context"*. Creative products and processes have been discussed extensively (for example see Boden, 1998; Plsek, 1997). People, domain and context are included in many creativity models (for example see Sternberg, 2005; Torrance, 1997; Csikszentmihalyi, 1997; Baer, 1998). As creativity has increasingly been recognised as important in RE, the question of how the above five creativity elements apply to the RE domain is of particular interest to the RE community.

Creativity Loci

Two loci of creativity can be defined: production and recognition; and adoption and diffusion. The first locus draws the creativity elements above together in order to facilitate the production and recognition of creative products. The second locus draws the same elements together in order to understand the adoption and diffusion of the creative products within their context of use.

Based on the two motivations for creativity research described in the introduction to his paper, creativity in RE occurs in the production and recognition locus with a view to inventing business visions and requirements that support ICT-enabled business innovation and handling complex and dynamic requirements problems. It is worth noting that the feedback loop between the first and second locus may play an important in the evolution of creative products (Carroll and Rosson, 1996; Hoffmann et al., 2005).

PRODUCT

The creative product, or creative outcome, is often described as having the following primary characteristics: novelty, value and surprisingness.

Novelty

The creative outcome has to be new and original**.** Boden (1991) differentiated two levels of novelty – individual, psychological or P-creative ideas, i.e. ideas that appear creative to the individual creator; and historical or H-creative ideas, i.e. ideas that appear creative to everyone. According to Boden, P-creativity can be examined at an individual level while H-creativity requires a broader historical and cross-cultural analysis. Sosa and Gero (2003) introduced the S-(situated) level of creativity which occurs as a result of a confluence of individual effort as well as the collective cultures of professional domains and social groups (organizations, communities) in the production and the diffusion of the creative product.

In RE, a new understanding has emerged: systems analysts must invent and discover business requirements to develop innovative solutions to business (Robertson, 2005). It is widely acknowledged that requirements are embedded within a specific organisational setting (Jirotka and Goguen, 1994). Synthesising levels of novelty and views, we suggest that novelty in RE is produced and judged at an appropriate S level, and subsequently at the P level, but not always at the H level. Novelty in RE is defined and judged at a collective professional level in a specific business domain and an organisational context. Hence, opportunities exist to explore approaches to understanding novelty (such as Boden, 1998; Kaufmann, 2004) and frameworks to measure novelty (such as Couger and Dangate, 1996) to examine how to produce and recognise novelty in RE at an appropriate S-creativity level. Our suggestion implies a relation between novelty and two other creativity elements: a process to produce a novel technology solution (the creative product) and the context (development community, organization, industry sector, and society) within which the product is judged as novel.

Value

A creative product should also be useful **(Sternberg, 1999; 1997)**, or workable and effective in solving a problem. Jackson and Messick (1965) described value through appropriateness including correctness as well as fit of the creative product with the context of use. Depending on the context of use and domain of application (for example in visual and performance arts, business decision making, or engineering projects), value can be

seen from different perspectives, for example aesthetics, monetary, or functionality. In RE, creativity is required to handle the technical complexity and develop a technically sound (i.e. correct) solution and conform to human needs and business goals (usefulness). In addition, the technology solution must fit with the organisational setting to be accepted by users. A focus group with practitioners (Cybulski et al., 2003) highlighted concerns by business managers that business constraints take precedence over creativity and thus limit opportunities for creative solutions in RE. First, this stresses the goal-oriented nature (usefulness and correctness) as well as the environment constraints (fit) in accepting creativity in RE. Second, in addition, this reminds us of the multiple viewpoints held by different stakeholders involved in the requirements process. Therefore, value in RE, defined at S level, is subjectively perceived and collectively agreed to in assessing creative technology solutions.

Surprisingness

Surprisingness is often associated with creative products (Macedo and Cardoso, 2002). Jackson and Messick (1965) described surprisingness as an impact of the unusualness and unexpectedness which "may shock or amaze us". Surprisingness is often experienced through unexpected features, such as an unusual application of or combination of existing thoughts and ideas; unpredicted transformation of problem space (Boden 1991); or the (unanticipated) simplicity of a solution to a complex problem (Mayer, 1992). Two requirements examples provided in Nguyen and Swatman (2003) relate to the surprising simplicity of the solution and the transformation of the problem space.

Bruner (1962) further asserted that the shock of recognition is a temporary quality because surprisingness often has an obvious nature. This is a challenge when assessing the requirements solution since the assessment often takes place in a retrospective manner; hence the obviousness is often experienced by the involved systems analysts and business community. Consequently, surprisingness needs to be 'captured' during the RE process.

In summary, characteristics of a creative product include novelty, value (usefulness, correctness, and fit), and surprisingness. The first two characteristics are included in Couger and Dangate's (1996) approach to measuring creative IS products, i.e. the final software product, while the third characteristic is missing in the RE and IS literature. Interestingly, having criticised current software engineering methods as value-neutral, Boehm **(Boehm, 2005)** proposed value-based requirements engineering focusing on the creation of business value through the discovery of requirements and systems value propositions. Within S-creativity, the notion of value of the information system needs to be further explored and examined from the perspectives of different stakeholders including business and IT managers, business users, systems developers and systems analysts. Without a comprehensive understanding of value and its connection to context and people involved, managers may not be able to recognise the value of, and therefore feel reluctant in accepting, creative solutions. Clearly, value must take precedence over all other characteristics; however, to promote creativity in RE, novelty and surprisingness, two other essential characteristics of creative products, cannot be ignored. Two questions arise: how to define and assess S level novelty**,** value **and surprisingness** of the creative outcome in RE**?**

PROCESS

Boden (1991) described the creative process as an internal process of exploration and transformation of conceptual spaces in an individual mind. However, understanding how this internal process actually happens has long been a challenging issue. We believe that if we can demystify, describe and model the creative process, we would be able to enhance individual creative potential and facilitate the creativity process. Shneiderman (2000) described three views of creative processes: inspirationalist, structuralist, and situationalist. This is a useful way to relate creativity process models to the requirements process.

Inspirationalist

While acknowledging that genius is one percent inspiration and ninety-nine percent perspiration (Edison, 1903), and recognising the steps of problem understanding, solution generation and evaluation, inspirationalist authors tend to study how insight - the magical "Aha!" moment - occurs and emphasise an individual's creative cognitive processes.

Wallas's (1926) model is the dominant inspirationalist creative process model. Wallas's model describes a creativity process model as consisting of four stages: preparation, incubation, illumination (insight), and the verification and expression of insight. Creativity involves an unconscious mental process and insight is seen as a breakthrough by unconscious ideas when at the moment Aha!, a long-sought idea and/or solution (at the unconscious level) suddenly appears at the conscious level. This is referred to by many problem solvers as illumination or insight. After that, the problem solver works on the verification and implementation of the insight to produce an effective and useful solution.

Wallas's model is supported in Gestalt psychology - a dominant school of thought in the problem solving literature (Mayer, 1992; Ohlsson, 1984; Wertheimer, 1959). In Gestalt psychology, problem space restructuring plays a crucial role in the conceptual exploration of the problem through revealing a new way of looking at the problem, often from a broader perspective. Restructuring is often associated with the occurrence of insight which often involves a surprise and solves the problem. How to trigger insight, however, still remains an unsolved puzzle: "A restructuring event has an involuntary character; it is experienced as something that 'happens', rather than as something the problem solver 'does' " (Ohlsson 1984, p.69).

Insight and restructuring of problem space described in the inspirationalist creative process can be related to observations of insight-driven reconceptualisation of requirements and restructuring of the requirements model in RE (Carroll and Swatman, 1999; Nguyen et al., 1999; Nguyen et al., 2000; Nguyen and Swatman, 2003). According to these authors, the requirements process consists of cycles of building up the requirements model and occasionally restructuring it often as a result of insight. In software design, insight-driven and opportunistic behaviours were reported in the 1990s (Guindon, 1990; Khushalani et al., 1994; Robillard, 2005). Overall, inspirationalist creative processes occur in RE and need to be supported.

Structuralist

Structuralist authors tend to emphasise systematic approaches to exploring and solving problems (for example Osborn, 1979; Daupert, 2002; Plsek, 1997). Their creative process models were influenced by an alternative theory to problem solving (Kant and Newell, 1984; Newel and Simon, 1972; Holyoak, 1990). According to this theory, problem solving involves the rational, systematic and structured search for information; and evaluation and selection of alternative solutions. The core of structuralist creative processes lies in the deliberate generation and evaluation of ideas. Therefore a structured, guided process of divergent and convergent thinking exists in various structuralist process models.

Creative Problem Solving (CPS) (Osborn 1979, Daupert 2002) and Directed Creativity Cycle (DCC) (Plsek 1997) are two representative structuralist creative process models. The CPS model consists of six steps: Mess-Finding (look for high level objective and goals), Data-Finding, Problem-Finding, Idea-Finding (divergent thinking), Solution-Finding (convergent thinking) and Acceptance-Finding (Daupert 2002). The DCC model consists of four phases, each consisting of overlapping activities leading from one to the next phase (Plsek 1997). The Preparation phase starts with an observation of how things work around us and an analysis of what works and what does not. The latter enriches our mental store of concepts and useful memories and leads to the next phase. The Imagination phase involves the generation and harvesting of novel ideas and associations between them. The Development phase involves an enhancement and evaluation of ideas. During the Action, the evaluated ideas are implemented. These structuralist creative process models tend to move away from unconscious process and seek a deliberate, systematic effort to generate ideas and produce value of the outcome.

RE, based on software engineering principles, is often described as a structured, systematic and evolutionary process to incrementally move closer to a correct and complete final specification of user requirements (Pohl, 1994; Loucopoulos and Karakostas, 1995; Jackson, 2005). While it seems that RE methods can be extended to support structuralist creative process models such as CPS or DCC, surprisingly these have not been included in dominant RE **approaches**, such as Unifed Modelling Language **(such as Booch** *et al.***, 2005)**.

Situationalist

Situationalistists emphasise the role of human and social environment and professional domain in the creative collaborative process. Communication and collaboration are core activities in the situational creative process. **A new model (Shneiderman, 2000) was** developed **to support** interactions and collaboration amongst colleagues. **This** model consists of four phases: Collecting information from the public domain and available digital sources; Relating, interacting and consulting with colleagues and teams; Creating, exploring, composing, and evaluating solutions; and Disseminating and communicating solutions within the team and storing solutions in the digital sources. While Shneiderman's (2000) model broadens the problem solving process to enable creative teams to share ideas and information, idea generation and evaluation activities are grouped into one phase – Creating. Hence, the model tends to describe a structured collective process as the sum of (communication and sharing of) individual creative processes. A more solid understanding of collective creative processes is required.

Overall, the situationalist view incorporates the communication of creative ideas within teams and thus has the potential to be aligned within core RE activities including requirements communication, negotiation and agreement (Nuseibeh and Easterbrook, 2000). Opportunities exist to explore approaches to understanding and supporting group work and collaborative creativity (such as Cross and Cross, 1995; Nunamaker et al., 1987) in RE. Research into supporting creative teams and distributed cognition in RE has started (Blackburn et al., 2006).

Discussion

We suggest that the RE process requires and accommodates each of the inspirationalist, structuralist and situationalist views. First, there is a similarity between the 'debate' between structuralist and inspirationalist views on the creative process and two paradigms in describing the requirements process. In RE, Nguyen and Swatman (2006) summarised two views on the requirements process – one describing a structured systematic requirements process and the other describing an emergent, reflective requirements process involving occasional insight and restructuring of the requirements model. Nguyen and Shanks (2006) relate these two views to paradigms of design processes described by Dorst and Dijkhuis (1995) - a rational problem solving process (Simon, 1992) and a reflection-in-action process (Schön, 1996). The analogy between different descriptions of problem solving across creativity research, RE and design studies is a manifestation of two 'forces' in problem solving: the enforcing of a systematic structured process to avoid a chaotic error-prone process, and the recognition and taking advantage of opportunistic cognitive behaviours and professional heuristics. Both these two forces are essential in RE problem solving; a **pragmatic** balance of them is required.

Second, inspirationalist and structuralist models tend to describe an individual thought process and lack collaborative work and contextual factors which are essential in RE professional practice. The situationalist model, while emphasising the communication, interactions and collaborations between problem solvers, lacks support for internal intensive cognitive processes exercised by creative individuals. Both modes of individual and collaborative creativity occur and need to be supported.

Hence, all three views on the creative process are not mutually exclusive in the RE process. An integration of the three views within the creative RE process should be supported. A solid understanding of the creative RE process is required to extend current RE methods and processes in order to explicitly support creativity. An integrated RE support environment with creativity techniques and tools to support the creative requirements process will have potential benefits for RE practice.

PEOPLE

Investigating the personal characteristics and traits of prodigies - for example Freud, Mozart, Poincare, and so on – has been a useful way to understanding creativity (for example Gardner, 1993a; Loveless, 2002; Guildford, 1950; Tardif and Sternberg, 1997; Torrance, 1997). Based on Tardif and Sternberg's (1997) classification framework, we review and suggest a list of common characteristics of highly creative persons (see Table 1).

Overall, previous authors suggested a rather wide set of personal characteristics of creative individuals. As pointed out by Tardif and Sternberg (1997), there is also a notable conflict amongst previous authors: the social isolation and social integration tendencies in creative individuals. This conflict and the wide set of personal characteristics could be explained by the fact that previous authors studied different individuals in different fields. People may be creative in a particular domain because they use their knowledge as a base when generating new ideas (Tardif and Sternberg 1997, p.434).

Traits	Cognitive abilities	Problem solving styles
• originality • articulate • fluency (in generating ideas) • courage and willing to take risk • high intelligence • self confidence • sense of humour • persistency	• metaphorical thinking • sensibility of problems • flexibility • independent thinking • openness to novelty • thinking outside a perceptual set • finding order in chaos • having aesthetic sense and good imagination	• using existing knowledge as a base for new ideas • holistic thinking approach • building new structures • logical thinking approach • experimentation • internal visualisation

    Table 1. Common personal characteristics of creative individuals:

An interesting question arises: whether and which of the above characteristics are desirable and are possessed by successful practitioners in the RE domain as they are not often recognised as H level prodigies? And if so can these qualities be prompted and trained? Empirical studies in RE (Cybulski *et al.*, 2003; Dallman *et al.*, 2005) showed a number of creativity factors from an individual aspect. Amongst them, risk taking personality is found to be important. Two other factors, personal agenda and hidden motivation, are related to the social isolation tendency. The tension between pursuing one's agenda/motivation and producing a creative solution (to be accepted by peers) needs to be further explored in RE. This is important in supporting the situationalist view of the creative, collaborative RE process. Other factors including perception of being creative, creativity education, and past experience suggest an important role of education and experiential learning in training creative systems analysts. If creativity techniques may be selected and integrated within the RE process to support the creativity process, can creativity techniques prompt systems analysts to acquire desirable characteristics and be (more)

creative? Recently, researchers seek ways to include creativity in the IS and RE curricula (Sweeney, 2003; Armarego, 2004; Nguyen *et al.*, 2005).

DOMAIN

Is creativity domain general or domain specific?

The role of domain is strongly recognised in Csikszentmihaly's (1997) systems view of creativity. First, the domain provides a symbolic system and a body of knowledge of a discipline, for example performing art, novel and creative writing, engineering, sport, medicine, etc… Solomon et al. (1999) related the notion of domain to Gardner's (1993b) eight different types of intelligences and suggested that a creative individual should have good knowledge about a recognised domain, but neither be too "enmeshed' in the domain nor too far away from the domain knowledge. Second, the correctness, fit, and novelty of the creative product have to be defined within a particular domain and the state of art in that domain.

Root-Bernstein and Root-Bernstein (2004) held an opposing view. According to them, creative abilities are rather domain general and creative individuals share common intuitive and cognitive tools, such as observing, imaging, abstracting, pattern recognising, body thinking (emotions and body movements reflecting the general human thinking state), empathising, transforming and synthesising. Therefore, one can be creative in different domains, for example a scientist can be artistic or an artist can be scientific.

Is the distinction between creativity domain specificity/generality important to creativity education?

Plucker and Beghetto (2004) conceptualised domain specificity and domain generality through two dimensions - one is age and experience, and the other is interest and commitment. As people mature and gain experiences, they become more domain specific in their creative exercises. As people get interested and commit to a specific domain, their creativity becomes domain specific. Plucker and Beghetto (2004) concluded that knowledge transfer and flexible thinking are crucial in creativity education; the specificity/generality issues should not matter.

In contrast to the above argument, Baer and Kaufman (2005) contended that the distinction matters in creativity training for individuals. They suggested integrating domain general and domain specific aspects of creativity through the Amusement Park Theory (APT) model of creativity. Creativity moves from domain general to more specific as we go through different levels in the model, from initial requirements, thematic areas, domain, and finally to micro-domain. The APT model has potential benefits in exploring creativity in general as well as in specific domains, such as RE.

Discussion

In Sternberg's view (2005), knowledge is domain specific and creative abilities range from domain specific to domain general. The RE domain forms a specific professional discourse, including elicitation and modelling techniques, processes and notations. RE specific knowledge and skills as well as domain general creativity abilities such as fluency in idea generation, sensibility to problems, analytical and synthetic skills are required to explore and structure the user requirements and come up with novel and effective technology solutions to business. Moreover, professional practice in RE often involves multiple application domains from time to time. It is important to explore and identify different aspects of domain generality and specificity in RE. This exploration will potentially lead to the design of an effective creativity education program in RE. Creativity education is currently not integrated in most RE training programs and curriculum. As a result, students show a lack of creativity techniques when exercising RE and dealing with open ended problems in RE (Dallman et al. 2005, Armarego 2004). Armarego (2004) proposed a creativity problem based learning framework for RE education. Her initial evaluation of the framework showed positive results and indicated inconsistencies in students' perceptions and expectations of the role of creativity in RE. Aspects of domain generality/specificity and personal characteristics may be integrated within a creativity training framework in RE.

CONTEXT

Creativity is defined in a specific socio-organisational context involving collaborative teamwork and social processes and agreements (Csikszentmihaly (1997). Creative products are the result of social collaborative teamwork. According to Warr and O'Neil (2005), social influences may foster/block idea generation, lead to an apprehension of being evaluated/rejected, and permit/forbid free-rides in team work. Team cognitive diversity (synthesis, procedure, organisation, political know-how and social network access) was found to influence team creative production (Kurtzberg, 2005). The diversity in an individual's education, work experience, and background culture may facilitate heterogeneous idea generation or hinder knowledge sharing and common

understanding (Kurtzberg and Amabile, 2000-2001). There are different types of conflicts in collaborative teams: task-based, process-based and relationship-based. While in general all types of conflict potentially negatively affect group brainstorming, task-based conflicts may lead to more creative options. In RE, group conflicts may lead to less productive idea generation (Maiden and Robertson, 2005). Future studies will be required to guide systems analysts in overcoming types of conflicts which have negative impacts on teamwork. A conceptual framework synthesising Situated Action, Extended Cognition and Distributed Cognition theories has been developed to form a basis for developing ICT-enabled support for the creative team process (Blackburn et al., 2006).

At the organisational level, Amabile's (1988; 1986) studies found that intrinsic motivations and rewards which are relevant to specific tasks chosen by workers are conducive to creativity whereas extrinsic motivations and commissioned work are detrimental to creativity. In RE, these findings have implications for business and IT management: how to create an organisational environment with appropriate reward and task allocation processes to support their intrinsic motivations and help individuals recognise and realise their creative potential.

New products are assessed before they are adopted by immediate communities. Csikszentmihalyi (1997) discussed the 'gatekeeper role' of the social system within which new ideas are assessed, selected and transmitted to the domain and people. In RE, the production and judgement of creative products occur at the S level in a socio-organisational context. Initial studies (Dallman et al. 2005, Cybulski et al. 2003) found a number of organisational factors which influence creativity in RE. Fieldwork in commercial projects is required to further examine the socio-organisational factors and support the recognition and adoption of creative work in RE. Furthermore, Hoffman and his colleagues (2005) described effective creativity in systems development as well as flexibility to allow creative use by the end users and organisations. Research into supporting a feedback cycle of creative requirements engineering and creative use of systems is desirable.

DISCUSSION

This paper extends the current focus on techniques and processes in RE research into creativity. The paper discusses various creativity elements including product, process, domain, people and context found in the creativity literature and relates them to RE. These elements are not mutually exclusive; they are interrelated in exercising and judging creativity in RE. We summarise our insights about these elements in the table below.

Table 2 synthesises creativity elements discussed in the creativity research. The domain element is added to Plucker's (2003) definition of creativity. Compared to Csikszentmihalyi's three systems (1997) - people, domain and field (context) - product and process are included to explore creative outcomes and processes in RE. An understanding of characteristics of creative products and creative processes plays a central role in supporting the creative process and the recognition and adoption of the creative outcome in RE.

Our discussion about five creativity elements extends current understandings of creativity in RE. For example, domain element extends the C/RE model (Cybulski et al. 2003), a related conceptual framework of creativity in RE. Although C/RE was developed from an RE perspective rather than creativity research, in general C/RE consists of similar elements of product, process, and socio-organisational context including individual and organisational dimensions. Some details of C/RE elements vary from elements in Table 1. Simsion (2006) examined data modelling practice through interviews, surveys and laboratory studies, from the five elements environment, problem, process, product and person. At a high level of abstraction, an overlap exists between this set of elements and the elements suggested in table 1. Simsion's (2006) elements are described specifically within the data modelling domain. For example, the environment element describes the profession culture and technical discourse of data modelling – the beliefs and characterisations of data modelling held by the data modeller community. Simsion concluded that although data modelling should be recognised as a creative design process, it is primarily perceived as having a description characterisation by the data modelling community. This confirms a need for a further examination of the characteristics of the creative product – its added value and novelty introduced by the designer.

Creativity elements	Description	Implications for RE	RE creativity research
Product	• Novelty • Value • Surprisingness	• How can novelty, surprisigness and value be defined and determined in RE? • Need to study the collective assessment of creative ideas.	• Integrating creativity techniques to facilitate discovery of creative ideas and requirements in RE (Maiden and Robertson 2005).
Process	Three views: • inspirationalist • structuralist • situationalist	• These three views are not mutually exclusive. An integration of views is needed to support different creative thinking styles and processes in RE. • There is a need to have a solid understanding of the cognitive RE process by individuals and teams. • An integrated RE support environment with creativity techniques and tools to foster the creative requirement process is needed.	• Gaining an understanding of the RE process (e.g. Nguyen et al. 2000). • Evaluating creativity techniques within RE process (Maiden and Robertson 2005). • Supporting structuralist and inspirationalist creativity in RE (Nguyen and Swatman 2006).
Domain	A debate between domain generality and specificity views of creativity continues.	• RE involves multiple domains. Research needs to clarify domain general and domain specific aspects in RE. • RE education needs to address different levels of domain general and domain specific creativity with appropriate education frameworks.	• An education framework has been proposed to support constructivist and experiential learning (Armarego 2004).
People	A list of common personal characteristics identified and examined.	• Need to identify common personal characteristics (traits, cognitive abilities, and problem solving approaches) possessed by creative systems analysts. • Can creativity techniques and tools be integrated within RE to prompt and boost creativity abilities of systems analysts?	• Individual factors identified through initial empirical studies in an education setting (Dallman et al. 2005).
Context	Social processes in producing, assessing and adopting creative product.	• Need to understand and support collaborative creative team process in RE. • Need to create an organisational environment to support intrinsic motivations and appropriate reward scheme to foster creativity. • Need to inform the 'gatekeeper' (eg business and IT managers) of effective procedures to assess and adopt the creative product. • Creativity after development: How best to develop a precise requirements specification while still leaving room for creative use of the system. How can this feedback the subsequent RE?	• Investigate ICT enabled support for creative teams (Blackburn et al., 2006) • Organisational factors at different levels which influence creativity have been identified through a focus group and a case study in an education setting (Dallman et al. 2005, Cybulski et al. 2003).

Table 2. Implications of Creativity Research for RE

The paper suggests two broad implications for research and for practice. For research, we need to empirically examine how the creativity elements apply to RE and integrate them within RE methods to effectively foster and support creativity. For practice, organisations and practitioners should create an organisational environment to nurture and promote creative people, cognitive and collaborative processes and products. Creativity techniques and tools can be adopted to prompt systems analysts' creativity abilities and support the creative process. The integration of creativity techniques within RE methods and processes will advance the RE domain.

CONCLUSION

This conceptual paper integrates two bodies of knowledge: creativity research and RE creativity research. Creativity in problem solving involves individuals engaged in a cognitive and social collaborative process to produce a novel and valuable outcome which will be subject to evaluation within a specific domain and social context. The paper critically discusses characteristics of the creative product, different views on creative process models, the role of a specific domain, personal characteristics found in highly creative people, and socio-organisational aspects in supporting and judging creativity. The paper explores and conceptualises how these elements may apply in RE and builds a theoretical foundation to study RE creativity.

The creativity research field was awoken by Guildford in the 1950s. Over the four decades since, creativity research has been growing in importance both in psychology and more generally (Sternberg and Lubart, 1996, p. 686). Having discussed different aspects in styles, domains and processes, Sternberg (2005) concluded that these multiple views of creativity are complementary rather than mutually exclusive and suggested "future (creativity) models might integrate these diverse sources of individual differences". This is also the case in the RE domain – a young discipline. RE researchers need to recognise different creativity elements and integrate them within RE approaches.

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