Using an Ideas Creation System to Assist and Inspire Creativity in Requirements Engineering

Delin Jing[1(✉)], Chi Zhang[1,2], and Hongji Yang[1]

[1] Centre for Creative Computing, Bath Spa University, Corsham SN13 0BZ, UK
{delin.jing13,chi.zhang14,h.yang}@bathspa.ac.uk,
lytzhangchi@buu.edu.cn
[2] Tourism Institute, Beijing Union University, Beijing 100101, China

Abstract. Software product markets have become extremely competitive as there are always multiple software products striving to serve the users in the same application domain. In order to be successful, a software system needs to distinguish itself from other similar products and surprise users with novel and useful features. Obviously, creativity becomes much more important in a software engineering process, especially for requirements, as creative requirements engineering is crucial to new and surprising features or services. However, normally, with it focuses on elicitation, analysis, and management, research studies on requirements engineering do not offer strong support to creativity in requirements engineering. Naturally, services like idea generation can be involved to support creativity requirements engineering by eliciting innovative ideas from stakeholders. Although a considerable number of applications and research studies have been made in the past years in order to increase the effectiveness of idea making process, there is little work exists to design an ideas creation system for assisting and inspiring requirements. Meanwhile, it is lack of efforts working on creativity requirements in the requirements engineering perspective particularly. Therefore, the objective of this research paper is to propose an ideas creation system to assist engineering activities for generating creativity requirements. In particular, this paper designed an ideas creation framework and defined and classified a set of creativity elements according to creativity techniques. Then, it proposes a creative requirements engineering method that is supported by the designed ideas creation system and creativity elements, whilst the application domain is specific to the e-learning service. An inference engine is the kernel part in the idea generation process with domain ontology for the target field as the knowledge base. Hence, the generated ideas are inspiring stakeholders to get not only relevant and useful but also novel and surprising requirements.

Keywords: Requirements engineering · Creative requirements · Ideas creation · Creative computing · Creativity

1 Introduction

Traditionally, Requirements Engineering (RE) considers that requirements exist in the stakeholders' minds in an implicit manner [1], and focuses on models and techniques to aid identification and documentation of such requirements [2]. Current software product market, however, has become extremely competitive as there are always

L. Liu and M. Aoyama (Eds.): APRES 2015, CCIS 558, pp. 155–169, 2015.
DOI: 10.1007/978-3-662-48634-4_12

normally multiple software products striving to serve the users in the same application domain [2]. In order to sustain and be successful, a software system needs to surprise customers with novel and useful features [2]. Therefore, creativity is necessary to be involved to achieve this target, especially for requirements elicitation, because creative requirements are the beginnings of new and surprising features or services. However, existing studies to requirements engineering offers not much support to creativity. Idea generation, as a way to inspire individual or team members to generate more and new ideas, can be used as the fundamental process of getting innovative outcomes in various domains. Therefore, this paper suggests that a proper designed ideas creation system can be involved to support creativity in requirements by providing new, useful and surprising requirements to inspire and elicit innovative and clear requirements from stakeholders.

This research aims to provide an ideas creation system to assist engineering activities for creativity in requirements. In the following sections, firstly, background knowledge is explained following by reviews of related work. Secondly, an ideas creation framework is proposed with explanations of different phases. Next, based on creativity techniques, creativity elements are defined and classified, whilst corresponding rules of creativity elements' application are designed. The ideas creation system is to provide ideas as information that is able to help stakeholders to get clear and innovative requirements. Supported by creative computing techniques, including exploration, combination and transformation, the generated ideas are inspiring stakeholders to get not only relevant and useful but also novelty and surprising requirements. After the requirements elicited, they are presented as a mind map with special tags corresponding to defined creativity elements to indicate the requirements' various and specific demands on creativities, which makes the requirements formally formatted and provides convenience for the subsequent application design and development. Last, a case study is presented to illustrate how the proposed method works. Overall, the main contribution of this paper is the designed ideas creation system.

2 Background and Related Work

2.1 Requirements Engineering and Creative Requirements

Along with arise of creativity in software engineering, requirements engineering community has received a growing interest from researchers and practitioners. It emerges many papers discussed on the high level of creativity and requirements such as work from Lemos and his colleagues [1] and discussions from Maiden [3, 4] and Bhowmik [2]. Beside, some research studies worked on providing various techniques to do requirements engineering in creative ways, such as using Model-Driven Engineering [5], mind mapping [6] and reasoning [7]. Although there are efforts, they are not mature methods yet and it is still lack of ability to be implemented. Therefore, as mentioned in last section, this paper concentrates on using an ideas creation system to support creativity in requirements engineering. In particular, the ideas creation system is designed to provide clues to assist and inspire stakeholders on eliciting clear and innovative requirements. Moreover, a set of creativity elements are designed to help

on evaluating generated ideas in creativity perspective and to support requirements presentation by combining with mind mapping technique.

2.2 Creativity and Creative Computing

Creativity is an extremely important facet of life and is a feature of many of the tasks that people do every day. It can occur in a multitude of situations ranging from work to pleasure, from artistic portrayals to technological innovation [8]. Most texts regard creativity as a beneficial process in an organisation and it has been said to offer a competitive advantage in the design processes [9]. Naturally, it is a crucial feature for new and innovative ideas; consequently, creativity needs to be considered in the idea generation process.

According to Boden's definition [10], an idea can be called "new" from two perspectives: the objective (H-creative) and the subjective (P-creative) view. They derive from two kind of creativity: H-creativity (short for historical creativity) and P-creativity (short for psychological creativity) [11, 12]. H-creativity is fundamentally novel in respect to the whole of human history and P-creativity is the personal kind of creativity that is novel in respect to the individual mind [13, 14]. From the above discussion, the creativity expected in this paper should belong to H-creativity. Obviously, H-creative ideas are very difficult to be generated by individual or a group, especially on the creativity perspective, because it requires to be supported by extensive knowledge and creative techniques.

Because creativity is considered the ultimate human activity and a highly complex process [15], some researchers hold that the creative thinking process cannot be formulated, analysed, or reconstructed [13], [15, 16]. Others adopt a reductionist view that creative products are the outcome of ordinary thinking, only quantitatively different from everyday thinking [10], [14], [17]. By review related studies and developments, this research believes that creative ideas can be generated systematically, if there is a carefully designed supporting method, which is an ideas creation system in this research.

Similar to the definition of creativity, there is not a universal definition of creative computing. In last few years, creative computing is being discussed more widely, hoping to produce new, innovative and valuable products. Creative computing seeks to reconcile the objective precision of computer systems (mathesis) with the subjective ambiguity of human creativity (aethesis) [11]. As a newly aroused emerging research field, in creative computing, there are many promising research directions have been studied [18, 19], such as creative design, creative requirement engineering, and creative collaboration. One research objective in creative computing is to find the approach to get creativity and to realise it [11], [20]. Besides, creative computing can be recognised as the study of computer science and related technologies and how they are applied to support creativity, take part in creative processes, and solve creativity related problems. Creative application software, or called as creative application can be referred to those software, tools, or environment which can support, improve or enhance creativity using text, graphics, audio, video, and integrated technologies [21, 22]. Currently, there are researches working on approach and process to develop crea-

tive software from the beginning. However, it does not exist ideas creation system for creativity in requirements engineering.

3 An Ideas Creation Framework

In an earlier published paper [23], we proposed an ideas creation process as Figure 1 shows, which is a high level process suitable for general idea generation purposes. Specifically, there are three kernel phases to create new ideas including "Knowledge Extraction/Reuse", "Idea Generation" and "Ideas Evolution". Based on this process, this paper is to design a specific ideas creation system for assisting and inspiring creativity in requirements engineering. Thus, it focuses on the ontology construction and ideas' creativity evaluation, which belong to the first phase "Knowledge Extraction/Reuse" and the last phase "Ideas Evolution". A set of creativity elements is defined in next section to support the ideas' creativity evaluation. Besides, combined with mind mapping technique, the creativity elements supports requirements presentation. The following contexts explain more details on the three phases in Figure 1 to illustrate the entire ideas creation process.

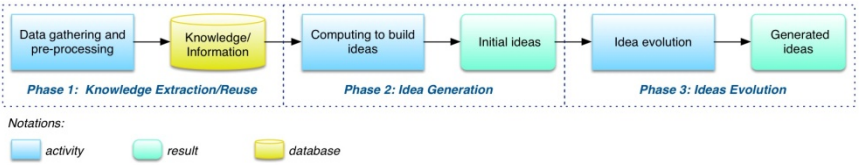

Fig. 1. Ideas Creation Process

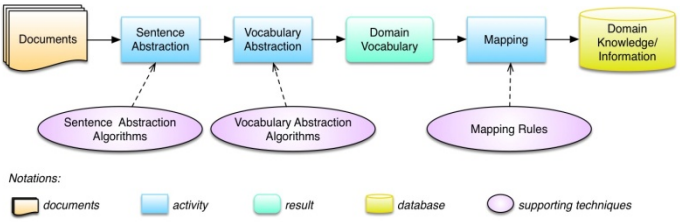

Fig. 2. Knowledge Extraction/Reuse in the Ideas Creation Process

Phase 1: Knowledge Extraction/Reuse. As Figure 2 shows, this phase is data gathering and pre-processing by adopting abstraction techniques, designed abstraction algorithms and mapping rules [24], and reusing knowledge bases [25]. The extraction part works as following description. Firstly, it determines the objective of task and selects relevant documents as raw data. Then the domain vocabulary is extracted from the text data supported by abstraction algorithms. Last, the extracted domain vocabulary is mapped into the ontology format to be the domain knowledge/information according to designed mapping rules. Because building an ontology from scratch is not only time consuming but also limited to gathered resources, moreover, the ontology based domain knowledge is reusable, thus, it is more efficient to reuse existing

domain ontologies to assist the construction of specific domain knowledge base. In particular, there are two circumstances in the knowledge reuse: 1) if a knowledge ontology exists for the required domain but is not up to date, it requires a smaller scale knowledge extraction to get the latest information and then merges the extracted information into the existing domain ontology to form the requisite knowledge base; and 2) if there is a knowledge ontology extracted recently for the required domain, the existing domain ontology will be reused directly as the knowledge base for the subsequent idea generation. In this paper, because the ideas creation system is designed to support creativity in requirements engineering, the knowledge base is ontology of requirements, which is more focusing on functions, features, etc. Furthermore, since the application field is narrowed down to e-learning service, the ontology is constructed for e-learning service. The above two points distinguish the ideas creation system from others.

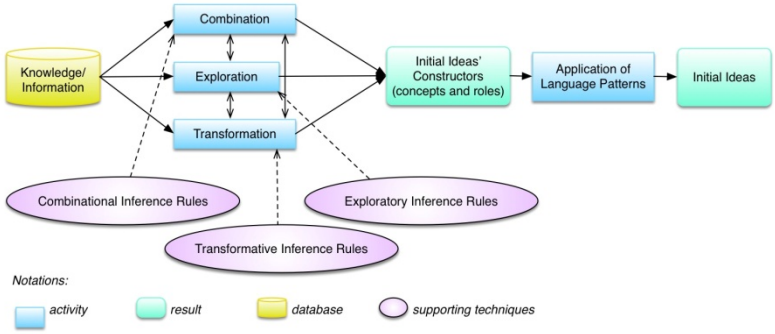

Fig. 3. Creative Idea Generation in the Ideas Creation Process

Phase 2: Idea Generation. It is computing to build ideas as Figure 3 shows. Based on gathered and processed knowledge, system computes following designed algorithms and rules to generate initial ideas to realise convergent thinking. Exploration, transformation and combination are kernel activities of its computing step to generate initial ideas. Combination activity involves unfamiliar combinations of familiar knowledge and information. Exploration activity explores within an established conceptual space. This is more likely to arise from a thorough and persistent search of a well-understood space. Transformation activity deliberately transforms a conceptual space. It should involve the rejection of some of the constraints that define this space and some of the assumptions that define the problem itself. These three kinds of activities provide the basis of the techniques to compute resources and generate initial ideas. The results of one activity can be input of another activity to generate ideas through multi-activities. However, it is not necessary to implement all three kinds of activities. The practical realities of their application must be worked out in different applications and circumstances, usually on a case-by-case basis. A set of inference rules has been designed in our previous publication [26] to support the proposed three activities as supporting techniques. Moreover, language patterns are proposed [26] to be applied to form the generated ideas as readable phases and sentences.

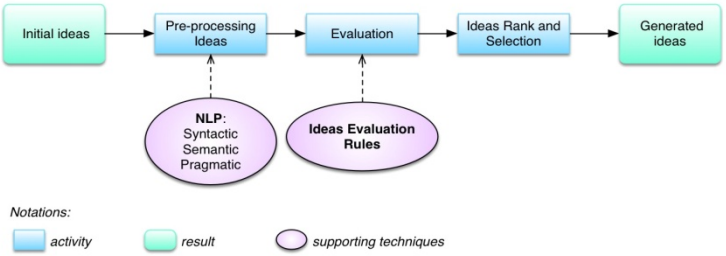

Fig. 4. Ideas Evolution in the Ideas Creation Process

Phase 3: Ideas evolution. It covers pre-processing, evaluation, ranking and selection as Figure 4 shows. The pre-processing is to analysis the generated initial research ideas as a good sentence and topic from language perspective. Natural Language Processing techniques are adopted to support the pre-processing, which include syntactic, semantic and pragmatic. After pre-processing, the evaluation part measures the ideas' creativity via designed metrics. In this paper, for the purpose of evaluating creativity of ideas, a set of creativity elements are defined in next Section to support the evaluation from three perspectives: novelty, usefulness and surprising. According to the evaluation results, the generated ideas can be provided to stakeholders as clues to help and inspire them on creativity in requirements.

4 Creativity Elements

Dean et al. [27] carried out an exhaustive analysis of studies that employed criteria to assess creativity in solution and product ideas [27, 28]. Based on review and analysis of selected 51 relevant studies, and for purposes of their quantitative tool, these researchers further broke these criteria into more specific and measurable terms including dimensions and sub-dimensions as shown on Table 1. In order to conquer the inconsistencies limitation on the previous studies, Dean and his colleagues [27] recommended adopting the naming conventions depicted in Table 1. Their research discussed that it helps to avoid confusion between novelty-only studies and creativity studies where creativity is based on novelty plus other quality constructs [27]. However, a creative outcome is unlikely can be effective if it is novelty only.

Besides, according to the definitions, novel, workable, relevant, and specific are on the same level while each of them has a set of sub-dimensions in the lower level. In the relationships refers to Figure 5, workable, relevant and specific are in the same level while novel is in a higher level. In hierarchical perspective, the relationships conflicts with the definitions of the constructs.

Fig. 5. Relationships among Constructs/Dimensions [27]

Table 1. Definitions of Quality Dimensions and Sub-dimensions [27]

#	Dimension	Definition
1	***Novelty***	The degree to which an idea is original and modifies a paradigm.
1.1	Originality	The degree to which the idea is not only rare but is also ingenious, imaginative or surprising.
1.2	Paradigm relatedness	The degree to which an idea is paradigm preserving or paradigm modifying.
2	***Workability (Feasibility)***	An idea is workable (feasibility) if it can be easily implemented and does not violate known constraints.
2.1	Acceptability	The degree to which the idea is socially, legally, or politically acceptable.
2.2	Implementability	The degree to which the idea can be easily implemented.
3	***Relevance***	The idea applies to the stated problem and will be effective at solving problem.
3.1	Applicability	The degree to which the idea clearly applies to the stated problem.
3.2	Effectiveness	The degree to which the idea will solve the problem.
4	***Specificity***	An idea is specific if it is clear (worked out in detail).
4.1	Implicational explicitness	The degree to which there is a clear relationship between the recommended action and the expected outcome.
4.2	Completeness	The number of independent subcomponents into which the idea can be decomposed, and the breadth of coverage with regard to who, what, where, when, why, and how.
4.3	Clarity	The degree to which the idea is clearly communicated with regard to grammar and word usage.

Overall, in our opinion, the proposed constructs, sub-dimensions and the relationships cannot directly employed in this research. There are limitations and conflicts in various levels. However, some of these researchers' methods are worth to be adopted. Specifically, this research proposes a set of creativity elements and corresponding sub-dimensions by adopting Dean and his colleagues' [27] way to define constructs. Also, similarly, a hierarchical structure is useful on the relationships among the proposed creativity elements and sub-dimensions.

Boden [10] says a creative idea is novel, surprising, and valuable. Most important, creative ideas should be surprising because they go against out expectations [10]. That is to say, a creative idea should be not only rare but also be ingenious and imaginative. Thus, this research proposes three creativity elements: Novelty, Usefulness and Surprising. Novelty measures the idea is new from different perspectives. Usefulness is to make sure an idea is applicable and is worthy of study, which covers valuable, but not only that. Comparing with Dean and his colleagues' constructs, Usefulness actually contains relevance, workable and specific but with improvement to overcome their limitations and conflicts. Surprising measures the degree of ideas' unexpectedness and unusualness, that is how much ideas against out expectations and how much unique the ideas are, which distinguishes Surprising with Novelty.

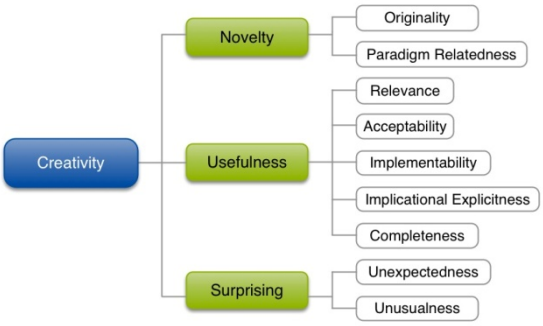

Fig. 6. Relationships of Creativity Elements and Sub-Elements

This research adopted some of sub-constructs from Dean et al. [27], redefined them accordingly, and re-catalogued into the proposed elements as their sub-elements. Figure 6 shows the hierarchical relationships of the creativity elements and sub-elements. In the following context, when the creativity elements and sub-elements are considered as a whole, it is referred as Creativity Elements (CE) for convenience.

4.1 Definitions of Creativity Elements

For the purposes of this research, which is to generate ideas for creative requirements of e-learning service, the proposed creativity elements and sub-elements are defined or redefined, depends on if it exists in previous research studies and suitable to be adopted. The following provide a more in-depth explanation of the respective elements.

- **Novelty**: The degree to which an idea is original and modifies a paradigm of e-learning requirements.
  - ***Originality***: The degree to which an idea is rare in H-creativity perspective. The low degree means the idea is common, mundane, boring. The high degree means the idea is not expressed before.
  - ***Paradigm relatedness***: The degree to which an idea is paradigm preserving (PP) or paradigm modifying (PM). PP ideas remain same concepts or same relationship between concepts with a paradigm. PM ideas extend concepts, or redesign or transform relationship between concepts. PM ideas are sometimes radical or transformational.
- **Usefulness**: An idea is useful if it can be easily implemented as a requirement and does not violate known constraints in the domain knowledge. It should be relevant to the specific domain or domains as well as workable (feasible) as a requirement.
  - ***Relevance***: The idea applies to research in specific domain/domains and will be effective as a research according to user's input. In other words, it covers both domain relevance and input relevance.
  - ***Acceptability***: The degree to which the idea is acceptable (not conflict knowledge constraints). Low acceptability means the idea violates knowledge constraints. High acceptability means the idea does not violate knowledge constraints.

- ***Implementability***: The degree to which the idea can be easily implemented as a requirement. Low implementability means the idea is hard to achieve or hard to get valuable outcomes as a function or feature. High implementability means the idea can be implemented as a requirement well.
- ***Implicational explicitness***: The degree to which there is a clear relationship between the recommended action and the expected outcome. Low implication explicitness means the implication in the idea is not stated or less relevant. High implication explicitness means the implication in the idea is clearly stated and makes sense.
- ***Completeness***: The number of independent subcomponents into which the idea can be decomposed, and the degree of the subcomponents expressed in the idea.

- **Surprising**: It is about the unexpected degree of the ideas.
  - ***Unexpectedness***: The degree of the idea goes against out the user's expectation.
  - ***Unusualness***: The degree of the idea distinctiveness, that is how much unique the idea is.

4.2 Creativity Elements for Requirements Engineering

The above creativity elements are proposed to support requirements engineering, particularly on requirements presentation. To achieve this aim, it is designed to combine with the designed ideas creation system and mind mapping technique to support requirements elicitation and presentation respectively as Figure 7 shows. In particular, the creativity elements work in the ideas evolution phase to classify the generated ideas according to the defined creativity elements. If a generated idea is classified into one or more creativity elements and adopted as a requirement by the stakeholders, corresponding tags for creativity elements will be added into the specific requirement's node when the requirements are presented as a mind map. Thus, the majority affect and aim of the creativity elements is to bring clear vision of creativity on requirements presentation.

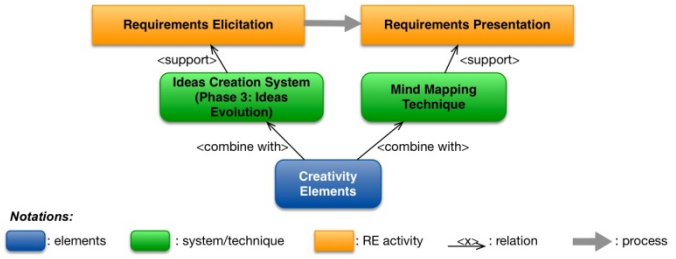

Fig. 7. Creativity Elements for Requirements Engineering

4.3 Designed Tags and Rules for Creativity Elements

This paper adopts tags as the way to mark creativity in requirements. Each creativity element and sub-element has a corresponding tag, which is designed as <element name> format and named as "CE Tag". Table 2 lists all the creativity elements with

their corresponding CE Tags. The CE Tags indicate the requirements' various and specific demands on creativities.

Table 2. Creativity Elements and Corresponding CE Tags

Creativity Elements	CE Tags
Novelty	<novelty>
Originality	<originality>
Paradigm relatedness	<paradigm relatedness>
Usefulness	<usefulness>
Relevance	<relevance >
Implementability	<implementability >
Acceptability	<acceptability >
Implicational Explicitness	<implicational explicitness >
Completeness	<completeness >
Surprising	<surprising>.
Unexpectedness	<unexpectedness >
Unusualness	<unusualness>

Besides, mind mapping is employed as a basic technique to support requirements presentation. Following rules are designed for applying the above designed CE Tags into the mind mapping process. Basically, the designed rules can be classified into two categories as below shows,

Rules for Creativity Sub-elements:

If a requirement satisfy all of the following conditions (a)-(c),
(a) a requirement is a node in mind map;
(b) this node has no CE Tag; and
(c) this requirement belongs to creativity sub-elements.
then
add this sub-element's corresponding CE Tag in front of this mind map node. (1)

If a requirement satisfy all of the following conditions (a)-(c),
(a) a requirement is a node in mind map;
(b) this node has one or more CE Tags; and
(c) this requirement belongs to one creativity sub-element that different from existing CE Tags represented sub-elements.
then
add this sub-element's corresponding CE Tag in front of this mind map node; and merge it with other CE Tags in this node. (2)

Rules for Creativity Elements:

If a requirement satisfy all of the following conditions (a)-(d),
(a) a requirement is a node in mind map;
(b) this node has at least one sub-node;
(c) this node has no CE Tag; and

(d) there are sub-elements' CE Tags in one or more of its sub-nodes.
then
add CE Tag in this node and the added CE Tag represents creativity element that contains the sub-elements corresponding to the CE Tags in condition (d). (3)

If a requirement satisfy all of the following conditions (a)-(d),
(a) a requirement is a node in mind map;
(b) this node has at least one sub-node;
(c) this node has at least one CE Tag; and
(d) there are sub-elements' corresponding CE Tags in one or more of its sub-nodes that not included in this node's CE Tag.
then
add CE Tag in this node, while the added CE Tag represents creative element that contains the sub-elements corresponding to the CE Tags in condition (d). (4)

If a requirement satisfy all of the following conditions (a)-(d),
(a) a requirement is a node in mind map;
(b) this node has at least one CE Tag;
(c) this node has no father-node between itself and root node; namely, this node is directly linked to root node; and
(d) it cannot be categorised into another node.
then
add a father node for this node, give the father node an abstract name, and add high level creativity elements' CE Tags according to CE Tags in condition (b). (5)

If a requirement satisfy all of the following conditions (a)-(d),
(a) a requirement is a node in mind map;
(b) this node has at least one CE Tag representing creativity sub-element;
(c) this node has no father-node between itself and root node; namely, this node is directly linked to root node; and
(d) it can be categorised into another node.
then
link this node with the other node that is identified in condition (d) as a sub-node; and run rule (3) or (4) for its new father node depending on whether this father node's has CE Tag. (6)

5 Case Study

This section discusses requirements engineering for a Chinese (Mandarin) e-learning application to demonstrate and prove that the proposed ideas creation system is feasible to be applied to support creativity in requirements engineering. Its ultimate goal is to provide an ingenious application allows users to explore innovative ways to learn Chinese. An ontology of e-learning service is the first thing needed for the ideas creation system. As there is not exists an ontology suitable to be used directly, a new ontology of e-learning service is constructed as the knowledge base. Figure 8 shows part of the ontology's graphical representation in Protégé.

Fig. 8. Part of the E-Learning Service's Ontology in Protégé

Details about idea generation phase are omitted here as it is followed the designed approach and rules in our earlier papers [25], [29]. Figure 9 shows the input and output screenshots of the developed ideas creation system. A user can be a stakeholder, an application designer or a domain expert. To use the ideas creation system, a user needs to select a domain and enter some keywords as the system input. The domain is the application's domain, whilst keywords are other relevant information. Concerning this case study, it is suitable to select "Language E-Learning" as the domain and to enter "Chinese", "Mandarin" and "Application" as keywords. Through the idea generation process, the final generated results are listed in the output interface.

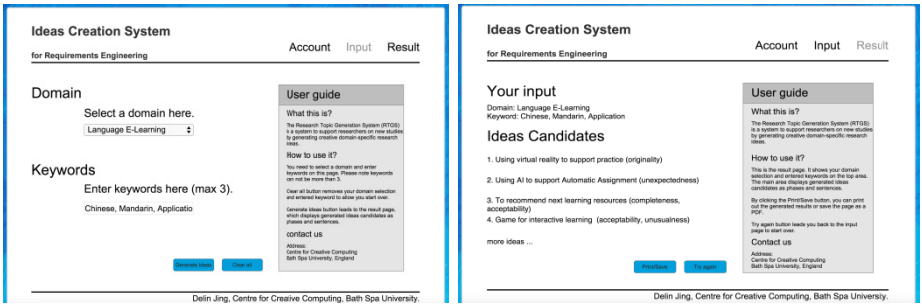

Fig. 9. Input and Output Screenshots of Ideas Creation System

The defined creativity elements help to evaluate creativities for generated ideas as requirements. After adopting all the generated four ideas, the requirements are presented in a mind map with CE Tags as Figure 10 shows, which is ready to be processed in the further software engineering phases to develop the target application.

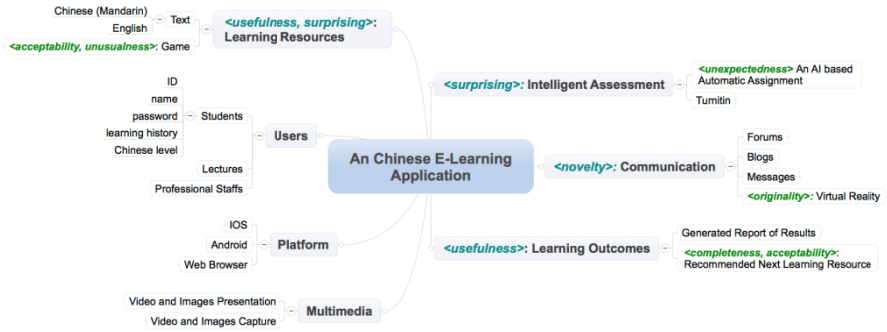

Fig. 10. Final Requirements Mind Map for the Chinese E-Learning Application

6 Conclusion

This research paper proposed an ideas creation system to assist engineering activities for creative requirements development, which aims to cope with the software domain's rapid development and intense competition. In particular, an ideas creation framework is designed with three phases to provide ideas as clues to help and inspire requirements elicitation. Also, creativity elements are defined and classified according to creativity techniques, which are to evaluate creativities in generated ideas and to support requirements acquisition via proposed CE tags and designed rules. The applied CE Tags indicate the requirements' various and specific demands on creativities, which make the requirements formally formatted and provide convenience for the subsequent design and development. Furthermore, a Chinese e-learning application is selected as a case study to illustrate and prove the feasibility of the proposed ideas creation system for creativity in requirements engineering.

References

1. Lemos, J., Alves, C., Duboc, L., Rodrigues, G.N.: A systematic mapping study on creativity in requirements engineering. In: 27th Annual ACM Symposium on Applied Computing (SAC 2012), pp. 1083–1088. ACM, New York (2012)
2. Bhowmik, T., Niu, N., Mahmoud, A., Savolainen, J.: Automated support for combinational creativity in requirements engineering. In: 22nd IEEE International Requirements Engineering Conference, pp. 243–252. IEEE Press, New York (2014)
3. Maiden, N.: Creativity in software engineering: a new research Agenda? In: 18th IEEE International Conference on Program Comprehension, pp. xiv. IEEE Press, New York (2010)

4. Maiden, N., Ncube, C., Robertson, S.: Can requirements be creative? Experiences with an enhanced air space management system. In: 29th International Conference on Software Engineering, pp. 632–641. IEEE Press, New York (2007)
5. Assar, S.: Model driven requirements engineering: mapping the field and beyond. In: 4th IEEE International Model-Driven Requirements Engineering Workshop (MoDRE), pp. 1–6. IEEE Press, New York (2014)
6. Mahmud, I., Veneziano, V.: Mind-Mapping: An effective technique to facilitate requirements engineering in Agile software development. In: 14th International Conference on Computer and Information Technology (ICCIT), pp. 157–162. IEEE Press, New York (2011)
7. Schmid, K.: Reasoning on requirements knowledge to support creativity. In: 2nd International Workshop on Managing Requirements Knowledge (MARK), pp. 32–39. IEEE Press, New York (2009)
8. Bonnardel, N.: Creativity in design activities: the role of analogies in a constrained cognitive environment. In: 3rd Conference on Creativity and Cognition, pp. 158–165. ACM, New York (1999)
9. Cook, P.: The Creativity Advantage: Is Your Organisation The Leader of The Pack? Industrial and Commercial Training, vol. 30, no. 5, pp. 179–184. MCB University Press, Bradford (1998)
10. Boden, M.A.: The Creative Mind: Myths and Mechanisms, 2nd edn. Routledge, London (2004)
11. Yang, H., Hugill, A.: The Creative Turn: New Challenges for Computing. International Journal of Creative Computing 1(1), 4–19 (2013). Inderscience
12. Hugill, A.: Creative computing processes: musical composition. In: 8th IEEE International Symposium on Service Oriented System Engineering, pp. 459–464. IEEE Press, New York (2014)
13. Koestler, A.: The Act of Creation. Hutchinson, London (1964)
14. Perkins, D.N.: The Mind's Best Work. Harvard University Press, Cambridge (1981)
15. Goldenberg, J., Mazursky, D., Solomon, S.: Creative Sparks. Science **285**, 1495–1496 (1999)
16. Bono, E.D.: Lateral Thinking: Creativity Step by Step. Harper & Row, New York (1970)
17. Zhang, J., Ma, J., Zhang, D., Tan, R., Source, A.K.: CAI-Driven new ideas generation for product conceptual design. In: IEEE International Conference on Management of Innovation and Technology (ICMIT), pp. 824–830. IEEE Press, New York (2012)
18. Carroll, E.A., Latulipe, C., Fung, R., Terry, M.: creativity factor evaluation: towards a standardised survey metric for creativity support. In: 7th ACM Conference on Creativity and Cognition, pp. 127–136. ACM Press, New York (2009)
19. Nguyen, L., Shanks, G.: A Framework for Understanding Creativity in Requirements Engineering. Information and Software Technology, vol. 51, pp. 655–662 (2009). Butterworth Heinemann, Newton, MA
20. Jing, D., Yang, H., Xu, L., Ma, F.: Developing a creative idea generation system for innovative software reliability research. recently published In: 2nd International Conference on Trustworthy Systems and their Applications. (2015)
21. Janssen, D., Schlegel, T., Wissen, M., Ziegler, J.: MetaCharts-using creativity methods in a CSCW environment. In: Human-Computer Interaction Theory and Practice (Part II), pp. 939–943. Mahwah, New Jersey (2003)
22. Weiley, V., Pisan, Y.: The distributed studio: towards a theory of virtual place for creative collaboration. In: 20th Australasian Conference on Computer-Human Interaction: Designing for Habitus and Habitat, pp. 343–346. ACM Press, New York (2008)

23. Jing, D., Yang, H.: Domain-Specific 'Idea-tion': Real Possibility or Just Another Utopia? Recently Published in: Applied Science Journal (2015)
24. Jing, D., Yang, H., Tian, Y.: Abstraction Based domain ontology extraction for idea creation. In: 13th International Conference on Quality Software (QSIC), pp. 341–348. IEEE Press, New York (2013)
25. Jing, D., Yang, H., Shi, M., Zhu, W.: Developing a research ideas creation system through reusing knowledge bases for ontology construction. In: 39th IEEE Annual Computers, Software and Applications Conference (COMPSAC), pp. 175–180. IEEE Press, New York (2015)
26. Jing, D., Yang, H.: Creativity techniques based inference activities and rules for idea generation. In: 3rd International Symposium on Software Technology, pp. 1–8. (2015)
27. Dean, D.L., Hender, J.M., Rodgers, T.L., Santanen, E.L.: Identifying Quality, Novel, and Creative Ideas: Constructs and Scales for Idea Evaluation. Journal of the Association for Information Systems **7**, 646–698 (2006)
28. Puccio, G.J., Cabra, J.F.: Idea generation and idea evaluation: cognitive skills and deliberate practices. In: Mumford, M.D. (ed.) Handbook of Organisational Creativity, pp. 189–215. Elsevier Inc, London (2012)
29. Jing, D., Yang, H.: Creative computing for bespoke ideation. In: 39th IEEE Annual Computers, Software and Applications Conference, pp. 34–43. IEEE Press, New York (2015)