Enhancing the Creativity Process by Adding Context Awareness in Creativity Support Tools

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Abstract. The existence of creativity support tools establishes creativity as part of the Computer Science research. Therefore, the development of computational methods for the enhancement of creativity is undoubtedly a challenge. In this paper we argue that adding context awareness in creativity support tools will enhance the creativity process. This belief is based on the evaluation of a number of the most popular creativity support tools in relation to the features and characteristics they support. In this review, we examine the characteristics related to the interaction between the user and the creativity support tools in two phases: the *'preparation'* of creativity process and the *'ideation'* phase. Through this analysis we observe that the tools in most cases play a passive role. Real time Human-Computer interaction is missing, and therefore the creativity process is not as effective as it could and should be. Finally, we conclude that the addition of context awareness in creativity support tools can enhance the creativity process and innovation.

Keywords: creativity, innovation, learning, context awareness, and creativity support tools.

1 Introduction

HCI research deals with finding methods for creating human-computer interactions that are more effective, efficient and pleasurable. Context awareness is established in Computer Science through the development of context aware techniques and technologies for the improvement of human-machine interaction. From the early years of research in context awareness the aim was to develop intelligent methods which would make the computer become aware of the user's needs. This marked the beginning of several studies in the HCI area like cognitive environments, adaptation, personalization, etc. In the work presented, a combination of the aforementioned studies is used for the enhancement of the creativity process with the use of creativity support tools. The proposal for the addition of context awareness for the enhancement of the creativity process is supported through the presentation of context awareness. An evaluation of creativity support tools is also presented. Through the evaluation of the

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tools and the research analysis on context awareness, this work reaches the conclusion that the addition of context awareness in creativity support tools can enhance the creativity process.

In particular, the paper is structured as follows. In the first section the relation between Innovation, Creativity and Learning is presented. Section 2 presents the existing creativity techniques. Section 3 presents the most popular creativity support tools and their characteristics. Section 4 is a description of context awareness and how this could affect creativity process and section 5 describes how context awareness could be used within the creativity support tools. The paper ends with conclusions and a discussion on the future work.

2 Innovation, Creativity and Learning

The fundamental research in creativity for many years was considered to be a mainly psychology research topic. The meaning of the word creativity, as this can be found in dictionaries, is the *ability or power to create.* Hewett *et al.* through an overview and analysis of psychological research on creativity, supported that creativity can be considered to be the development of a novel product that has some value to the individual and to a social group. In the same study, a summary of the research findings given by [15] are presented by giving the dimensions of creativity. The creativity dimensions can be expressed as:

1. Property of people, products and of a set of cognitive processes.
2. A personal and a social, societal or cultural phenomenon.
3. A common or frequent being or it can be thought of as being rare.
4. The involvement of domain specific characteristics. There are also domain independent or general phenomena as well.
5. Quantitative or qualitative being.

The dimensions of creativity gave a new perspective to the meaning of creativity. Creativity can be considered as a cognitive process. That could be considered as the beginning of creativity research in Computer Science.

Creativity in Computer Science was initially used for the solution of complex problems. Analyzing the dimensions of creativity and motivated from the results on solving complex problems using principles of creativity, scientists tried to form creativity as a cognitive and computational model. Thus new definitions for creativity were born, related to Computer Science. At the same time several creativity techniques were developed.

Atman *et al.* [1] proposed 9 design steps that were developed mostly for engineering and are being increasingly used in the commercial product design life cycle:

- Problem definition
- Information gathering
- Generation of ideas
- Modelling
- Feasibility Analysis
- Evaluation
- Decision

- Communication
- Implementation

Schneiderman [14] proposed 8 steps of creativity:

- Searching & browsing digital libraries
- Consulting with peers & mentors
- Visualizing data & processes
- Thinking by free associations
- Exploring solutions, What if tools
- Composing artefacts & performances
- Reviewing & replaying session histories
- Disseminating results

The steps of creativity can be the basis for the development of a traditional creativity support tool. Nowadays this is not considered adequate. Today users of creativity support tools are not satisfied with an editing environment of writing ideas and saving them. The evolution of the social collaborative networks like *Facebook* and *mySpace* gave a new perspective to the aspect of creativity and innovation. Cougar [3] perceives creativity at three levels: as discovery method through the idea generation, as invention with the development of ideas, and as innovation with the transformation of ideas into services [10]. Thus creativity and innovation can be considered as relative meanings. The connection between the two is the *knowledge background* which is mandatory for creativity and innovation, but also the *knowledge effort* coming out of them. From this point of view the perspective of creativity and innovation through learning can be beneficial.

Creativity, Innovation and Learning can coexist and be efficient within a cooperative social environment. Within a social environment the creativity process can be used for the enhancement of the learning procedure and vice versa. Karapidis *et al.* [10] presented the potential of improving the development of a process using creativity and learning, through the following actions:

- Encouragement of the addition of ideas in all phases of a service process
- Discussion of new ideas
- Assessment of new ideas
- Building a pool with knowledge relevant for service process
- Discussion and further development of knowledge relevant for service processes

The development of a social cooperative platform supported by context awareness can be the solution for the improvements proposed in [10]. Social computing combined with context awareness can significantly enhance creativity and learning with the consideration of two more improvement factors. The interaction of people belonging to a specified domain and the recommendation of resources during the creativity process can enhance both creativity and learning.

2.1 Creativity Techniques

Today several creativity techniques are used for the development of the creativity support tools (http://www.mycoted.com). There exist more than 170 known creativity

techniques; however, many of them are rarely used in existing creativity support tools. The existing techniques can be grouped according to the result which can be produced from their use. A simple grouping of the techniques is given in (http://www.mycoted.com), where techniques are used for *Problem Definition, Idea Generation, Idea Selection, Idea Implementation, Processes.*

- Problem Definition is used to clearly define a problem, redefine a problem or specify all the aspects describing a problem. Creativity techniques used for Problem Definition are *Assumption Busting*, *Backwards Forwards Planning, Chunking, Five Ws and H and Multiple redefinition.*
- Idea Generation is the process of creating ideas. Creativity techniques used for Idea Generation are *Brainstorming* and *Taking Pictures*
- Idea Selection is the process of converting the ideas into solutions. Creativity techniques used for Idea Selection are *Anonymous voting, Consensus Mapping, Idea Advocate and Sticking dots.*
- Idea Implementation is the process of making the ideas reality.
- Processes are the schemes and techniques which look at the overall process from start to finish like *Free Writing, Creative Problem Solving, Synectics and Thinkx.*

An alternative grouping for creativity techniques is proposed in [12]. Based on the fact that one of the aspects characterizing a creativity technique is the applicability to the current usage context, [12] proposes the grouping of creativity techniques based on the usability of a technique according to the current context. Two criteria categories of the context factors are defined, *hard criteria* and *soft criteria.* The hard criteria include the *physical requirements, single and group technique* and *emotions.* Soft criteria include the *web usable, time* and *data/technique.*

3 Creativity Support Tools

Research in creativity led to the development of the creativity support tools as means for the enhancement of creativity beyond the classic psychometric methods. Creativity support tools can provide guidance and facilitate the creativity process for the users by monitoring the process and the produced results [13]. Creativity support tools are used to simulate the creativity techniques and create environments which guide the user to become more creative. Through the years a lot of creativity techniques were proposed. Based on these techniques, or a combination of them, a lot of creativity tools were proposed and developed. Considering the fact that people react differently with each creativity technique and aiming to find how creativity support tools could enhance the creativity of a person, in this work an evaluation of the existing creativity tools was made. With the evaluation of the existing tools we aim to track the characteristics supported, and find the missing points which would enhance the creativity process. The following creativity support tools were evaluated:

- **Comapping** (http://www.comapping.com)**:** Comapping is a web-based application that is mostly used for quick and intelligent problem solving. It supports team collaboration for solving a problem, even if the teams are separated by geographical or time-zones. It supports real time collaboration and asynchronous sharing. The supported techniques of comapping are: Brainstorming, Mind Mapping (left to

right) and Problem Solving. It supports the importing and exporting of data from and to other creativity tools, in formats like Freemind, Mindmanager and MeadMap, as well as Microsoft office formats like rich text, presentations, excel, etc. The maps can be downloaded and stored for offline usage. The meta-model supported is the left to right mapping.

- **Mind Meister** (http://www.mindmeister.com)**:** Mind Meister is a web-based application that supports Mind mapping and Collaborative Brainstorming techniques. It supports importing and exporting from Freemind and Mind Manager Creativity tools. It exports data in GIF, JPG and PNG format images, in rich text and PDF formats. It also publishes password protected maps. The meta-model used in Mind Meister is traditional directional maps. It also supports real time collaboration.
- **Google Docs** (http://docs.google.com)**:** Google docs are used for the creation of text documents within the web browser. The user interface resembles the typical word processor. The created documents can be shared with other users and can be collaboratively authored. The documents can be saved on the local machine of the user, or uploaded from the local hard drive to the user's account. They can be exported as PDF, HTML, csv, ods, txt and xls formats. Through the Google docs tool the user can discuss with other team members, and can publish the document on a given URL.
- **MindManager 8** (http://www.mindjet.com)**:** MindManager 8 is using the mind mapping creativity technique. Several features are supported by MindManager 8 making it an interactive visual creativity application. It interacts with Microsoft office tools like MS Word and MS Outlook, and offers to the user the ability to view and edit Microsoft files directly within the tool. Web Services for the addition of data to the created maps are supported. The user can collect data from Google, Yahoo, Amazon and more. It supports embedded web browser and a database linker to Oracle, MySQL, DB2, MSSQL Server, Access, Excel, CSV and text files. Exporting of a map as PDF, image, web page, mpx and Mindjet Player file format. It gives to the user the ability to create a group and organize a meeting with other participants. The selected users are selected from the user's contact list. MS Word files, MS Outlook Tasks and MPX files can be imported and processed. It can be used as a single user application or as a real-time collaborative application using file exchange.
- **Thinkature** (http://thinkature.com/)**:** It supports Mind Mapping, Collaborative Brainstorming and Idea Organization. With Thinkature the user is able to use a whiteboard to write ideas. He/she is able to take notes during the creativity process. The composition of a group of users for collaboration is supported. The selected users can be found from the user's contact list. The members of a group can communicate via chat. A user can add images to the map and use various coloring and fonts formatting, drag and drop topics. The meta-model used is Mind Map structure. Importing and exporting functionality is not supported.
- **TRIZ** (http://en.wikipedia.org/wiki/TRIZ)**:** TRIZ is a methodology, tool set, knowledge base and model based approach for generating innovative ideas and solutions for problem solving. It provides tools and methods for use in problem formulation, system analysis, failure analysis, and patterns of system's evolution. The TRIZ approach for problem solving is based on finding the best previously well solved problem and propose the analogous solutions with the minimum harmful

effects. It includes several methods and tools such as, 40 Inventive principles which are used for the solution of contradictions, contradiction Matrix, which is a database of known solutions (principles), Technical contradiction method, Physical contradiction method etc. TRIZ is using ARIZ (a program for the exposure and solution of contradictions); Su-Field Analysis (produces a structural model of the initial technological system, exposes its characteristics, and with the help of special laws, transforms the model of the problem).

4 Context Awareness

In literature several attempts to define Context were made [2], [13]. The most complete definition for Context was given by [5]: "Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application including the user and applications themselves". This definition is giving to the context a multidimensional perspective of use. The context is not absolutely related to a single research area or category. It can be applied in several research areas like e-learning, healthcare, ubiquitous computing, e-commerce, etc. In each case the methods of the context's integration and use differs. The differences are dependent on the domain the Context is applied to and on the context elements which are defined for modeling the Context.

Context awareness applications use human computer interaction and the interaction of the environmental conditions that the user is surrounded by, to collect information and create or retrieve the corresponding context. The necessary actions, the events, or the signals that a context awareness application needs to start functioning, in order to become aware of the context, are the context elements. The context elements can be hardware or software implementations depending on the kind of context they present.

The research in Context Awareness applications led the researchers to the development of methods for modeling the context. The interaction between a context aware application and the physical environment must be expressed by a bridging model that describes the entities of the real world and their interactions [7]. Key value, Markup Scheme, Graphical Models, Object Oriented, Logic-Based and Ontology Based are some of the context modeling methods.

5 Context Awareness in Creativity Support Tools

From the evaluation of the existing creativity support tools, the lack of context awareness is obvious. In the existing creativity support tools there are no recommendations from the system supporting the user during the creativity process. The user is responsible for finding the resources, defining his group associates without knowing their roles, level of expertise, competences or domain of interest they belong to. One of the disadvantages of the examined creativity support tools is the fact that all of them are implemented supporting only one creativity technique, mostly brainstorming.

The addition of context awareness can help to deal with some of the shortcomings tracked in the evaluation of the existing creativity support tools. Context awareness,

with the use of the specific context elements, will be able to generate recommendations for the user. The use of personalization methods in combination with context awareness can make the system aware of each individual user. The recommendations coming out from the context engine will aim to enhance the creativity process.

Creativity support tools can be used either by a single user or a group of users. The creativity process in both cases is dependent on the knowledge background, and the social influence of the participants. The existence of automated recommendations from the system can influence the result of a creative process positively. In this work the creativity process within a creativity support tool is observed in two phases. The first is the "preparation" phase. During the preparation phase the user is called to define the problem and set the objectives of the presumable result. At the same time, he has to compose the group with the participants of a session. The second phase is the "Ideation" phase. In the second phase the participants exchange ideas and interact with each other for the achievement of the initial objective. In both phases the system should support the user or the group of users, to be more creative and efficient by giving recommendations, something that the existing creativity support tools do not do.

The recommendations expected in each phase and the presumed influences in the creativity process are shown in table 1, which demonstrates the importance and the benefits of context awareness within the creativity support tools. Through the influences of recommendations mentioned in table 1 the perspective of learning through creativity by using context awareness is noteworthy. Context awareness within the creativity support tools gives to the tools the perspective of e-learning but not with the usual use of e-learning applications. Taking advance of the recommendations offered by the context awareness module the user or the group of user is able to collaborate with experts, find resources and find resources relevant to his interests.

5.1 Modeling Context in Creativity Support Tools

Modeling the context has been of significant concern to the researchers. Thus, several methods for modeling context have been developed. Which modeling method is the best, depends on the demands and the aims of the context engine as this is planned to be designed. The concepts and the parameters that will be triggered and contextualized are very important variants for the decision on the selection of the appropriate method. In the literature it is possible to find descriptions and examples of context modeling methods, like Key-Values, Markup Scheme, Graphical, Object Oriented, Logic-based and Ontology Based models [8], [13], [16].

A very important aspect in the development of creativity support tools is accessibility. Our proposition is the creation of a collaborative knowledge based creativity support tool. The proposed platform will be a web ontology based platform. Thus the context will be modeled as an individual ontology within the overall system. The ontology will contain the context elements which will be used for the enhancement of the creativity process.

Considering the factors influencing the creativity presented in [9], it is obvious that a context aware system designed for the enhancement of creativity process should be concerned with the following entities: user, social environment, system and task.

Table 1. Context Awareness in Creativity support tools - influences

Phase	Recommendations	Influence
Preparation	• Recommend users to participate • Recommend experts • Recommend solutions of related problems • Recommend resources related with the problem or the objective.	• Composition of groups with people of common grounding • Participation of experts with experience in the specified domain and experience from related sessions • Help for the correct definition of the problem and comparison with the previous (Innovation-Originality) • Resources help the users at the preparation phase to consolidate the problem and its objectives.
Ideation	• Recommend resources based on the given ideas • Recommend related ideas • Recommend methods of communication between the participants • Recommend creativity technique (if this is needed)	• Resources can enhance the knowledge on the objective of an idea and become the impulse for the generation of new ideas on the same subject • Relevant ideas can guide the user to new directions of research, so as to find more resources on the subject of interest • Proposition of communication methods can resolve problems of synchronous and asynchronous communication between the participants or personal communication with experts during the creativity process • One of the great challenges in context awareness. The recognition of the inefficient use of a technique and the proposition of an alternative which will make the participants more creative

The enhancement of the creativity process with the use of context awareness is possible to be achieved by means of recommendations made by the system to the user during the creativity procedure. The system has to be aware of the user. Thus, one of the context elements must be the user. User context element will collect the personal information of the user and a profile for him will be built. In the user's profile, data such as domain of interest and user role will be included. Social environment will also be a context element. The user will have a social role and he will be able to collaborate with others to generate new ideas. Social role is of great importance for the creation of social groups for interchanging ideas and opinions. Task will contain the problem definition and the ideas related with it. Finally, the system context element will collect the system's characteristics and technical requirements to ensure that the creativity process will be applicable to the computing system.

Defining context information, Haya *et al.* [6] supports that context information is actually transformed into context when it is used; thus any information can be understood by an entity as context. Continuing the definition for context information, it is supported that modeling the context information demands the transformation of

context information into *primary* and *secondary* context type. The *primary* context type can be defined as the main context information which has central role in the environment, e.g. *User* entity is the starting point for almost all the relations/associations between the entities. The *secondary* context type is useful but not so frequently used information. This approach is based on the two tier categorization proposed in [4].

The categorization into primary and secondary context type can be declared with the binary associations between the entities. For example *Task, User* and *Social Group* are primary context type information. On the other hand *Social role*, *User role* and *Portfolio* are secondary context type information. A secondary context type extends the primary entities model. This information is not frequently used and the context information is either requested from the user or is an automatic recommendation offered by the system.

6 Conclusions and Future Work

Creativity support tools and creativity techniques are significant means for the creativity process and, consequently, innovation. Knowledge background and knowledge effort are the key prerequisites for the achievement of innovation. In the work presented it was argued that the use of context awareness in creativity support tools can enhance the creativity process and therefore learning and innovation. Context awareness can be used in the creativity support tools by offering useful recommendations. The review of popular creativity support tools indicated the necessity of adding context awareness to them. The first step was to determine how context awareness can be used within creativity support tools and specify the types of recommendations needed in each phase of the process. Moreover, the description of the context entities and their modeling were presented so as to illustrate how context awareness can be formalized for its use in cooperative creativity web environments. In the future, we intend to use the findings of this work in the implementation of a context awareness engine for cooperative creativity support tools. Modeling the context and adapting it to an architectural prototype for context awareness engines using context reasoning and adaptation reasoning methods will be the first achievement. Therefore the adaptation of the context awareness engine and the implementation of evaluation mechanisms for the measurement of the creativity efficiency are demanded. Although creativity and creativity techniques are not measurable units, their contextualization is a great challenge and undoubtedly it will be a new beginning for context awareness and creativity research.

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