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Eureka! Past, present, and future of creativity research in HCI

by ***Umer Farooq***

Introduction to creativity

Creativity is the cornerstone of scientific development and progress. Scientific creativity can be characterized as a process toward achieving an outcome recognized as innovative by the relevant community [5]. Creativity has also been a traditional focus of study in psychology. Research on creativity can be traced to Jack Guilford's 1950 presidential address to the American Psychological Association (APA). Broadly, there are six categories for studying creativity [12]:

1. Psychometric: correlation and regression studies surveying, identifying, and constructing factors that can influence creativity.
2. Experimental: direct comparisons that systematically manipulate independent variables hypothesized to influence creativity.
3. Biographical: case study analysis of recognized episodes of creativity such as Kekule's dream about the ring-structure of benzene, or Watson and Crick's discovery of DNA.
4. Biological: measurement of neurological or other physiological a ctivity during creative task performance.
5. Computational: formal models of creativity, typically using artificial intelligence.
6. Contextual: descriptions of creativity as arising from social and cultural contexts.

Importance of studying creativity

Science is a social enterprise. The collaborative nature of science is emphasized by historians and philosophers of science, as well as sociologists interested in creation and diffusion of knowledge [11]. A central aspect of and reason for scientific collaboration is creativity.

Creativity is critical to invention, innovation, and social progress at both the individual and societal levels [4, 15]. Individuals are able to refine and improve their own performance, and groups, organizations, and societal institutions are able to sustain their existence and grow if and only if they can adapt and solve problems creatively in ever-changing circumstances [7].

Creativity research in HCI

Since the early 1990s, computer and information science researchers have studied creativity in the context of technology. The first conference on Creativity and Cognition was held in 1993. Since then, this conference has been held every three years, sponsored by ACM's Special Interest Group in HCI (ACM SIGCHI).

Creativity is an important focus of study in HCI for several reasons. First, there are assertions that today's knowledge workers can benefit from the use of software tools to enhance their creative strategies [4]. Second, existing tools for individual and collaborative work often contain interface elements that stymie creative efforts [3] and thus can be enhanced. Third, HCI as an inter-disciplinary field is conducive to more integrated investigations in traditionally diverse areas such as computing, psychology, art, music, and design among others.

Much of the focus of HCI research in creativity has been targeted toward developing tools that augment the creative process. Creativity tools for individuals enable a range of functions such as designing, sketching and generating ideas, viewing and exploring materials, composing music, creating art, etc. Some examples include: Qsketcher [1], an environment for composing music for film; Side-Views [17], supports experimentation and exploration of compound solutions by storing multiple versions of data; and MACSS [2], Macroscopic Composition Supporting System that offers a spatial representations of music to a composer to support the composition process.

Collaborative tools for supporting the social creative process have also been developed. For example, EVIDII allows designers to associate effective words and images, and then shows several visual representations of the relationships among designers, images, and words [13]. Showing different representations evokes individual designer's creativity by using design knowledge or representations created by other designers in the community, thereby supporting collective creativity.

Fischer [9] argued that distances across physical, temporal, and technological dimensions and diversity across different cultures are important sources for social creativity. He discussed several examples of collaborative environments to support creative processes. For example, in the Envisionment and Discovery Collaboratory, participants collaboratively solve design problems of mutual interest such as urban transportation planning. The assumption is that complex design is a social creative process, and the integration of individual and social creativity takes place through face-to-face discussions in a shared construction space such as an electronic whiteboard.

The Caretta system [16] supports face-to-face collaboration by integrating personal (for individual reflections) and shared spaces (for group discussions) to support intuitivism. Interactive art [10] is based on the premise that computational media enable people to operate at the source of the creative process by creating a pool of pixema, meaning individual pieces produced by different artists, which can be exchanged to synthesize new paintings. CodeBroker [18] monitors software developers' programming activities, infers their immediate task by analyzing semantic and syntactic information contained in their working products, and actively delivers task-relevant and personalized usable parts from a repository created by decomposing existing software systems. This ensures awareness of each other's work so that efforts are not duplicated and therefore, developers can be more creative.

The afore-mentioned tools broadly support some or all activities that are characteristic of creative endeavor, as outlined by Shneiderman [14]: (1) searching and browsing digital libraries; (2) consulting with peers; (3) visualizing data and processes; (4) thinking by free associations; (5) exploring solutions-what-if tools; (6) composing artifacts and performances; (7) reviewing and replaying session histories; and (8) disseminating results. Supporting such activities through creativity tools could reshape many forms of evolutionary creative work such as in scientific communities.

Collaboratories as frontiers for HCI research on creativity

One frontier for scientific collaboration is Computer Supported Cooperative Work

(CSCW), often codified and supported in collaboratories. Collaboratories are distributed computing infrastructures that provide access to instruments, data, and colleagues. Collaboratories were a major National Science Foundation/National Research Council research infrastructure thrust during the 1990s. The vision of collaboratories is that access to special equipment (e.g., a grid supercomputer or a unique planetary telescope) or special research sites (such as polar regions and the upper atmosphere) could be shared through the Internet, creating centers for geographically distributed scientists.

The original justification for collaboratories was more a matter of resource access and logistics than of enhancing creativity. However, it is surely plausible that having better access to instruments, research sites, datasets, and perhaps most importantly, to a critical mass of one's professional colleagues *ipso facto* facilitates opportunities for greater scientific creativity. It would be useful to directly elicit requirements to support creativity in collaboratories and systematically develop creativity tools based on those requirements.

Most recent research in HCI has attempted to systematically explore the design space for supporting creativity in collaboratories. Based on diverse theoretical and empirical investigations in social-psychological literature on creativity and groups, Farooq and colleagues [**6**] have elicited three design heuristics for supporting creativity. First, integrate support for individual, dyadic, and group brainstorming. During the creative work stage, group members alternate between times when they work alone, in pairs, and times when they meet as a group. Therefore, supporting these different brainstorming modalities and the alterations between them seems feasible.

Second, leverage cognitive conflict by preserving and reflecting on minority dissent. Research suggests that minority dissent during scientific endeavors stimulates convergent and divergent thinking. Moderate task-related conflict and minority dissent in a participative climate will lead to innovation by encouraging debate and to consideration of alternative interpretations of information available, leading to integrated and creative solutions.

Third, support flexibility in the granularity of planning. Although more detailed plans can lead to creativity, imposing such constraints can be problematic. For example, one of the classical findings in HCI is that workflow systems for planning tasks are successful in supporting structured activity, and otherwise may be too rigid, can potentially stymie creativity, and users often find ways to work around them. Flexible, more opportunistic and less imposing, planning tools with different levels of detail could facilitate creativity.

In reviewing HCI literature, I have found that there is a dearth of applicable theoretical frameworks and evaluation techniques for creativity. The focus has largely been on design, which is quite understandable as HCI is an applied science dealing with socio-technical interventions. However, for HCI to evolve and contribute significantly in this area, developing inter-disciplinary theoretical foundations and multi-method evaluation techniques is critical for understanding, investigating, and enhancing creativity in the context of technology. Collaboratories are an ideal platform to explore theory, design, and evaluation of creativity.

My own research in this area and the motivation to write this article is driven by the impetus to support distributed communities of scientists in working more creatively and thus effectively with their peers around the world. Focusing on scientific collaboration that involves everyday creativity, the sort that all of us evince in our daily lives, is the key to positively affect the quality of collaborative interactions between scientists, both face-to-face and distributed. Although analyzing outstanding creative people contributes toward establishing a framework for creativity, understanding creativity in the context of everyday activities is equally important for letting people become more productive and create better work processes and products [8].

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Biography

Umer Farooq (**ufarooq@ist.psu.edu**) holds an M.S. in Computer Science from Virginia Tech. He is currently a third year Ph.D. student in the Information Sciences and Technology program at The Pennsylvania State University. He has extensively worked on collaborative architectures for supporting community software. More recently, he has been investigating how to support distributed scientific communities and their creative processes. His main research interests include HCI, CSCW, community computing, and creativity.