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Can Creativity be Enhanced by Computational Tools?

Daniel Lopes*, Jéssica Parente*, Pedro Silva*, Licínio Roque and Penousal Machado

University of Coimbra, CISUC, DEI and LASI, University of Minho

{dfl, jparente, pedros, lir, machado}@dei.uc.pt

*These authors contributed equally

Abstract

The history of graphic design suggests that the introduction of new tools in people’s workflow might promote new creative paths. This article discusses the impact of computational tools on performing creative tasks. We conducted semi-structured interviews with twelve professionals working on graphic design, data science, computer art, music and data visualisation. The results suggest scenarios in which it may be worth, or not, investing in developing creativity-enhancing tools.

Introduction

Looking backwards at the history of humanity or making a retrospective into our daily creative practices, it is noticeable that the use of different tools may introduce new creative possibilities. This study aimed to understand how creativity may be impacted by the introduction of computational tools, by studying and comparing non-computational, creativity support, e.g. desktop-publishing or photo-editing software, and Computational Creativity (CC) tools (co-creative and fully autonomous). To achieve this, we conducted semi-structured interviews with professionals working on Graphic Design (GD), data science, computer art, music and data visualisation. Most were experienced in more than one area. Despite including several creative areas, the research was primarily focused on GD. The answers were analysed and discussed to summarise the insights.

The remainder of this paper is organised as follows. The Background section presents a brief review of the literature regarding (i) creativity and the evolution of design tools (computational and non-computational); (ii) creative systems outside the design field; and (iii) studies on enhancing creativity. The Interviews section describes the research and discusses the results. Conclusions and Future Work summarise the work and present future research directions.

Background

Although the definition of creativity might not always be consensual, it is often accepted that novelty is one of the fundamental characteristics to define creativity (Boden 1996), and it may be achieved by exploring or extending the existing space of possibilities (Veale and Cardoso 2019). In the graphic design field, the introduction of the movable types

by Gutenberg in the 1450s and the *Unigrad* system by Massimo Vignelli in 1977 (Philip B. Meggs 2016) are historical examples of extending the creative space by introducing new tools. The digital revolution recently brought new design tools and fostered new design movements (Lupton 2014). Additionally, software democratisation and easy-to-use coding libraries, e.g. *Processing* (*processing.org*), fostered novel solutions such as animated and reactive designs (Shaughnessy 2012).

Concurrently, academics and practitioners started to explore Artificial Intelligence (AI) as a creative tool, establishing the Computational Creativity (CC) area — “*an emerging branch of AI that studies and exploits the potential of computers to be more than feature-rich tools, and to act as autonomous creators and co-creators in their own right.*” (Veale and Cardoso 2019). CC tools may be co-creative or fully autonomous. The first ones collaborate with humans in creative tasks, while the second ones generate creative artefacts without human assistance (Maher et al. 2018). Nevertheless, both have been successful in aiding creativity, for instance, in areas such as computational art (Romero and Machado 2007; Machado et al. 2014; Elgammal et al. 2017), music (Miranda and Biles 2007; Farzaneh and Toroghi 2019; Loughran and O’Neill 2020) or design (Martins et al. 2016; Parente et al. 2020; Lopes, Correia, and Machado 2022), by applying evolutionary or machine learning techniques.

Besides art and design, creativity may be necessary for fields such as engineering. According to Robertson and Radcliffe (2009), engineers may be both positively and negatively influenced by creativity-support tools, since these may provide (i) a better ability to visualise and communicate ideas within the work team; yet these may also cause (ii) technical difficulties to make major changes in the projects as these get more complex; and (iii) limited creative possibilities imposed by the constraints of the tools. The authors argued that using computational tools may not be the best approach to generate ideas, yet these may be helpful to complement the human creative process.

Work on creativity-enhancing frameworks has also been done. Nickerson (1999) presented a framework composed of twelve steps for teaching creativity. For instance, (i) “*providing opportunities for choice and discovery*” or (ii) “*strategies for facilitating creative performance*”.

Shneiderman and Plaisant (2010) referred guidelines for developing creativity support tools, such as making them (i) “*low threshold, high ceiling, and wide walls*”, (ii) collaboration supportive, (iii) “*as simple as possible*” and (iv) able to “*iterate, iterate, then iterate again*”. CC tools may also fit in these guidelines, suggesting that their development may be desirable as well.

Furthermore, the interest in creativity-support computational techniques can also be noticed in the increasing number of creative coding classes in universities, schools and online courses (Dufva 2018; Hansen 2019).

Research Approach

This study aimed to understand (i) the impact of computational tools in creative tasks, mainly focusing on GD; and (ii) whether or not the insertion of new tools (computational or not) would enlarge the creative possibilities (opening new paths to explore in different directions). Assuming that new tools are favourable for enlarging the creative spectrum, computational tools might also do so. In that sense, creativity support and CC tools (co-creative and fully autonomous) were studied.

Semi-structured interviews guided by sub-questions were revealed to be an adequate method to address the goals of this study, providing clear strategies for organising data-gathering, coding and analysis. We conducted audio-recorded face-to-face interviews to address the nuances of the participants’ language. Due to the nature of this research, only people who have worked with creativity-enhancing tools were included — 12 designers and computer artists (3 women and 9 men) working at the University of Coimbra (Portugal), from 26 to 61 years old with diverse backgrounds: (i) 3 seniors graphic designers; (ii) 2 senior CC researchers (iii) 3 PhD students researching on CC applied to graphic design; (iv) 2 PhD students researching on data visualisation; (v) 1 PhD student researching on data science and (vi) 1 PhD student researching on GD. The interviews took 15 to 30 minutes and were semi-structured by previously setting a list of 10 open-answer questions. If an answer responded to some further questions, we changed or skipped to avoid repetition.

Interview Analysis

To understand how computational tools may influence creativity, the research goal was decomposed into sub-questions: (i) do computational systems influence the creative process; (ii) is it worth investing in the development of creativity-enhancing computational tools; and (iii) how may CC tools be useful in the creative process. Therefore, these topics were organised under the following categories: (i) creative process and creativity; (ii) creativity-enhancing tools and their advantages; and (iii) CC tools.

Creative process and creativity

In the first questions of the interview, we aimed to understand the different backgrounds of the interviewees. Therefore, they were asked to describe the stages of their workflow and pinpoint the ones requiring creativity. It is important to

highlight that the interviewees answered according to their own definitions of creativity.

From the content collected, the following common, fundamental stages were identified: (i) understanding the problem and the project requirements; (ii) searching existing work; and (iii) combining solutions for getting a new result. Additionally, it was consensual that the interpretation of the problem and prior experiences/knowledge (which may be influenced by the context one lives in) could affect the outcome. It was also consensual that all the stages of the workflow might require creativity.

Moreover, two interviewees argued that even searching may imply creativity, not only to find a better search method but also to find the best search domain. Two other interviewees believed that the most creativity-demanding stage is implementation, and one other claimed the requirements-gathering stage may be the one requiring less creativity. Moreover, it was assessed that creativity may also come from outside the work process. For example, by occasionally observing natural events or daily routines.

Creativity-enhancing tools and their advantages

The second group of questions was related to the use of computational and non-computational tools and aimed to assess: (i) which tools were used the most; (ii) whether and how these were helpful in the creative process; and (iii) how computational and non-computational tools may differ and in which contexts these may be used.

The answers revealed that all the interviewees frequently used computational tools in their creative process. Also, part of them claimed to use creativity support, version control and planning tools during the implementation phase. Most believed that such tools were highly advantageous, for example, by speeding up processes or fostering exploration, allowing otherwise unthinkable solutions. Also, some claimed that the introduction of computational tools brought control over the entire workflow, allowing one to go back and forward in the developments. One respondent argued that computational tools may provide a basis for starting or unlocking creative blocks, and others referred to the benefit of the internet in improving team collaboration and community support and providing easy access to new tools. Also, thanks to the easy access and the facility of creation, some declared themselves dependent on some tools.

Even so, most interviewees still use analogue methods, such as books for research or paper for fast sketching. Some noted that when using analogue methods, they need to better reflect on the execution process and exploration. Most of the interviewees added that the project and its needs may define the tools that are the most advantageous, and a PhD student working on CC claimed that the combination of computational and non-computational tools may be an asset to generate more experimental and less standard results.

Computational creativity tools

The final set of questions of the interviews regarding CC tools aimed to understand whether or not (i) these may be useful in the creative process, i.e. may one be inspired by a machine’s outputs as one does by people’s work; (ii) can

people use these in real use scenarios; and (iii) is it worth the investment in research and development of such tools.

Most interviewees have expressed their interest in CC tools and believed that these may never replace human creativity, but complement it by increasing each others' capabilities. Nonetheless, there was a higher interest in co-creative tools over fully autonomous ones. Some admitted having used CC tools due to curiosity, to automate tasks or to access new functionalities, yet mostly to explore novel solutions.

From the above, one may infer that CC tools may foster new creative paths. Even so, some considerations were referred to: (i) such tools may be more effective on objective-evaluation issues; (ii) CC systems may be picked or adapted according to the projects; (iii) most defended that humans will always guide the process. However, others claimed that having machines replace some human creative tasks may not be a negative thing, as people may adapt and direct their capabilities to more unexplored creative tasks.

Conclusions and Future Work

To collect perspectives on how computational tools may affect human creativity, we conducted semi-structured interviews with people working in creative fields such as graphic and computational design. The questions aimed to cover the creative background of the interviewees, understand which tools they use and for what purpose, and finally, collect their thoughts on CC tools. After coding and classifying the answers into themes, a further analysis was conducted for summing up the insights.

The answers revealed that the creative process may not be mainly shaped by the computational tools themselves but rather by social and personal background knowledge, which may change the interpretation of the problem.

However, especially in the early stages, the increasing productivity related to the use of new CC tools may be claimed as well-established evidence, as these may amplify the exploration and speed of the processes. Moreover, these may bring higher levels of confidence to the users by permitting them to revise and reformulate earlier developments without disabling further ones.

Also, the interviewees agreed that exploring new tools may expand creative possibilities, leading to new solutions. For instance, exploring both analogical and computational tools is recommended.

When questioning the role of CC tools in the creative process, the interviewees demonstrated their interest in co-creative tools and referred to their value for searching for unexpected solutions. Some divergence surfaced regarding fully-automatic tools due to the fear of human replacement. Others think it may be a natural way for humans to move their efforts forward to unexplored creative tasks.

In sum and paraphrasing one of the interviewees, all professions, processes of thinking and execution change and evolve in accordance with the evolution of their tools. Furthermore, personal background and experiences may have a strong impact on the employment of creativity, namely, due to social and cultural reasons.

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