How Are Measures of Usability and Creativity Support Correlated?

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Figure 1: Five of the most important digital tools for creative knowledge workers as defined by study participants are examined using standard measures, indicating a correlation between of usability and creativity support

ABSTRACT

Creativity support tools (CSTs) are designed to support exploration, discovery, and innovation. However, we do not know to what extent the support for these activities correlate with the ease of use and ability to work rapidly, effectively, and with fewer errors. To examine the relationship between the concepts *usability* and *creativity support*, we present a preliminary study on what creative professionals (n=110) from various disciplines report to be the most important digital tools in their work (Word, Teams, Excel, Visual Studio Code, Photoshop). We deployed two well-established instruments, System Usability Scale and the Creativity Support Index. We found a clear positive correlation between the usability and creativity support, but it tended to vary depending on the type of digital tool. We discuss the potential causes of this correlation, and whether better usability in a tool might also result in better capabilities for supporting creative tasks.

KEYWORDS

usability, creativity, creativity support tools

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1 INTRODUCTION

The field of Human-Computer Interaction (HCI) has long focused on making software and digital tools more efficient and easier to use. In the early years of HCI, research focused on making experts' or trained individuals' interaction with computer systems more efficient. This interest has since expanded to also improve the general ease of use and the ability to intuitively interact with computers for an increasingly wider group of users, as digital systems have moved into ever more spheres of human practices [16]. Efficiency and ease of use are encompassed by the term *usability*. Since the development of the personal computer in the 1980s, efforts to improve usability have been widely successful in getting computers into the hands of people across a wide range of domains and in return learning from their interactions and experiences.

The success of these efforts is mirrored in the growth of HCI, which "keeps recasting its net ever wider"[35]. In 1997, Fischer & Nakakoji [11] emphasized the need for including creativity and innovation by examining how computational environments support creativity, pointing out tensions in creativity between order/chaos, constraints/freedom, and following/breaking rules. A similar perspective was introduced in 2006 in a report from the U.S. National Science Foundation based on a workshop on creativity support tools (CSTs):

> "usability and learnability have been studied regarding the quality of computational tools. Those concepts have been primarily measured in terms of efficiency and productivity. Designing tools for supporting creativity (in all of the three aspects described above), in contrast, needs to take into account new concepts

> that have not been considered within the traditional HCI framework."[25]

These initiatives are among the pioneering efforts to shift the perspective from a focus on usability and productivity to consider, at the same time, how computers could support creativity and innovation. The distinction between creativity support and usability was further examined by Shneiderman [40] who pointed to the development of creativity support tools as one of the grand challenges for HCI. Shneiderman called for developing tools that "enable users to explore, discover, imagine, innovate, compose, and collaborate", extending a prior focus on enabling users to "work more rapidly, effectively, and with fewer errors." [40].

1.1 Paper contribution and structure

As stated by Resnick et al. [34], the relationship between usability and creativity is not a simple dichotomy, nor is it clear exactly how they are correlated: "tools that are not effective and efficient will probably hinder creativity, but it isn't clear that the reverse will hold." During creative processes, errors or mistakes can be productive [17], and the creative process sometimes unfolds in a non-linear way [37] that might appear inefficient from the perspective of emphasizing usability as a key quality. While the efforts to establish creativity as an important topic have been successful, the theoretical and practical relationship between the concepts of usability and creativity support remains underexposed. It would seem plausible that a digital tool that is easy to use will also help facilitate a user's expression of creativity; however, such an assumed, complex correlation between usability and creativity support must be examined and disentangled. This paper aims to contribute new insight to the currently limited body of research on that topic.

Based on a preliminary study of usability and creativity support in five digital tools reported to be important to creative professionals (n=110), this paper explores the following research question: *How are measures of usability and creativity support in digital tools correlated?* Importantly, we study tools that are many creative professionals rely on, and not necessarily tools claimed to have a high degree of creativity support (i.e., CSTs). We discuss the results of this study in light of current research on creativity and theoretical perspectives on tool use. Since we consider this work an exploratory study designed to identify general patterns to be unpacked in more detail in future work, we have aimed to be concise in our presentation and discussion of these initial, empirical findings.

2 RELATED WORK

2.1 Usability and how it is measured

Usability is a pivotal concept in HCI and generally refers to the ease with which users can interact with a product or a software interface to achieve their intended goals. In other words, a product or a software interface affording a high level of usability is easy to navigate and use, helps users accomplish intended tasks, and minimizes user errors along the way. While these aims have arguably been central since the inception of the research field of HCI, the notion of usability did not become a focal point until the early 1990s with works such as [29], [27], and [3].

Similar to Nielsen & Levy [28], we consider usability a general construct that cannot be measured in its own right. Rather, it is related to parameters that may be measured in combination to offer a usability estimation of a system. [28] distinguished between subjective user preference measures and objective performance measures as two broad categories of measurable usability parameters. Objective performance measures pertain to aspects such as users' error rates and speed of completing tasks with a given system, while subjective user preference measures concern users' perception and appreciation of a system. These two factors have been found to be interrelated ([41]) so that a system, which users perceive to be more aesthetically inviting, is also more likely to be perceived as usable.

There are several measures for assessing usability, for an overview see [10]. In short, usability can be measured with both quantitative and qualitative methods, i.e., with the help of usability experts, industry experts, research scholars, and end users. Often-used methods are observations in situ, think-aloud protocols while using a tool [18], evaluation by experts [29], cognitive walkthroughs [32], or surveys ranging from complex and multi-faceted questionnaires [22] to simple and focused ones [5]. Each of these methods comes with inherent strengths and limitations, and there is an ongoing debate about which method(s) to employ for measuring usability. As a case in point, [3] argued that reliable measures of overall usability can only be obtained by evaluating representative tasks in representative environments.

A number of consolidated models for evaluating usability have been proposed. One example is Seffah et al.[39] who proposed a model called Quality in Use Integrated Measurement, which includes ten factors, 26 sub-factors, and 127 specific metrics. Overall, the authors suggested that usability can be measured through a combination of subjective and objective measures and, further, that a consolidated model can help in developing a usability measurement theory. Similarly, [24] developed the Purdue Usability Testing Questionnaire grounded in the theoretical tenets of human information processing. This model contains eight essential considerations pertaining to human factors organized within the paradigm of three information processing stages: perceptual, cognitive, and action stages.

In this preliminary study, we employed the **System Usability Scale (SUS)**, since it is the most widely-used questionnaire for assessing perceived usability [23]. The scale was developed in 1996 [5] and is a non-proprietary and simple instrument that yields a score of 0-100 (higher being better). It has been used in a wide array of studies with different tools and technologies [2]. The SUS consists of ten statements (e.g., "I thought the product was easy to use," or "I found the system very cumbersome to use."). Each is rated on a five-point Likert scale, ranging from "strongly disagree" to "strongly agree". One additional benefit of the SUS is that it has been used for decades, and benchmarks exist on averages across multiple studies (e.g., M=70.14 from 2,324 individual surveys [2]).

2.2 Creativity support tools (CSTs) and how they are measured

While the definition of creativity is a complex matter, creativity scholars commonly define it as entailing "both originality and effectiveness" [36]. Other definitions add the concept of *potential* [8] or synthesize constituting elements from existing work as a basis for a more elaborate definition: "Creativity is the interaction among *aptitude, process, and environment* by which an individual or group produces a *perceptible product* that is both *novel and useful* as defined within a *social context*" [31] (original emphasis). Given its elaborate formulation, we subscribe to this latter definition in the present study. In this way, the interaction between the concept of creativity and usability comes in the form of the environment as this would encompass the tools used by creatives.

Fields related to HCI has had a marked interest in developing digital tools to support creativity [13]. Within creativity-related HCI research, contributions predominantly come in the form of a novel system built by researchers [14]. Such a might seek to support foster creativity by using virtual reality [15], by using digitally imposed experiences of time constraints [4], or by digitally augmenting existing creativity techniques [33]. However, while the main focus of HCI is on building and evaluating new CSTs, some researchers have studied readily available, commercial CSTs such as AutoCAD, Microsoft Word, or Photoshop (e.g., [12, 26, 30]). A definition of CSTs has been proposed by Frich et al. [13] according to whom: "a Creativity Support Tool runs on one or more digital systems, encompasses one or more creativity-focused features, and is employed to positively influence users of varying expertise in one or more distinct phases of the creative process."

And vice versa, tools that are *not* primarily designed to support creative tasks may still be employed for creative purposes; for instance, spreadsheet software like Excel can be used to explore different forms of visualizations. Such cases are demonstrated in studies of idea management which have found PowerPoint to be a commonly used tool for designers to communicate and share ideas in teams [20]. This open interpretation of what constitutes a CST is mirrored in the empirical part of this paper, where e.g. Microsoft Excel is included in our assessment of usability and creativity support. We return to this in the Discussion section.

Some tools are deliberately designed to support creative tasks, as their design "encompasses one or more creativity-focused features" [13]. However, this might not always be the case. When e.g. Photoshop is utilized to create a new illustration for an online magazine ad, it seems uncontroversial to argue that this digital tool serves to support creativity. One the other hand, when a user launches Photoshop to batch crop a large number of images, it is harder to argue that Photoshop is used as a CST, insofar as cropping is arguably not a creative task per se. In this latter example, Photoshop might best be conceived as a digital tool that *is* designed to support creativity but is here used for a non-creative activity. This illustrates the importance of considering the context in which a (potentially) creative activity takes place.

Remy et al. [33] reviewed how CSTs are evaluated and found that many research contributions do not measure how well CSTs support creativity and, further, that the difference between evaluating the productivity of the process, outcome creativity, or usability is often hard to discern. This finding–that researchers sometimes conflate usability and creativity support in the evaluation of CSTs–is central to what we aim to address theoretically and empirically here.

In this study, we employed the **Creativity Support Index (CSI)** to evaluate how well a CST assists a user engaged in creative work. The CSI frames overall creativity support according to six dimensions: Exploration, Expressiveness, Immersion, Enjoyment, Results Worth Effort, and Collaboration [7], and then quantifies the degree to which a tool supports creativity. The CSI therefore differs from qualitative approaches such as interviews, contextual inquiry, and observations that have also been deployed to study creative professionals' tool use [12, 26]. These approaches offer important and rich, complementary descriptions of creativity support from a human perspective and are valuable in exploratory research projects. Each of the aforementioned six dimensions of the CSI is represented by two agreement statements, resulting in a total of 12 items (e.g., "It was easy for me to explore many different ideas, options, designs, or outcomes, using this system or tool," or "The system or tool allowed me to be very expressive"). It is important to note that the CSI does not provide a general score for a tool [7] but is designed to measure how well a CST works in relation to specific tasks and circumstances. This is accomplished by having 15 paired-factor comparisons in which the importance of the six dimensions is examined. This results in a weight of the overall score, which is 0-100, similar to the SUS [5]. Unlike SUS, though, CSI is a relatively new instrument, and so we are not aware of any systematic benchmarks or summaries of its scoring across tools or technologies. However, the CSI is introduced alongside a range of smaller studies by Cherry & Latulipe [7]. This research found that e.g. Google Docs for collaborative, creative writing yielded M=87.73 (SD=11.30), Photoshop for post-processing M=84.20 (SD=18.84), and Autodesk sketchbook for open-ended sketching M=64.79 (SD=17.06). Similar scores are seen in studies by e.g. Andolina et al. [1] and Schlagowski et al. [38].

3 METHODOLOGY

The study was conducted in two stages. We first conducted a larger pre-study with a pool of knowledge workers to determine for whom being creative is part of their work, and to probe what tools they consider most important. Based on the tools mentioned, we conducted a study of five of the most important tools with (n=110) creative knowledge workers, where we administered to CSI and SUS to one specific tool per participant. The procedure, participants, materials and analysis are all described in this section.

3.1 Procedure

3.1.1 Pre-study: Identify important tools and creative knowledge workers. To determine a subset of tools that would be representative and interesting to examine as the center of our discussion of usability and creativity support, we had 500 knowledge workers respond to a small survey. Each participant reported the three most important tools for them in their respective profession. Participants were also asked to provide a free-form description of their job title and indicate whether creativity was an core part of their profession. The median completion time was 1 minute and 37 seconds. On average, each participant was paid approximately GBP 11.10/USD

13.8/EUR 12.95 per hour. We excluded 169 responses from participants for whom creativity was not part an important part of their profession. From the remaining 331 participants, we selected five of the most commonly occurring tools: Word, Photoshop, Teams, Excel, Visual Studio Code. We built our main study around these five tools.

3.1.2 Main study: Survey of usability and creativity support in five digital tools important to creative professionals. We invited 112 participants from the pre-study to take part in the main study. The participants were included based on having listed one of the tools as one of their three most important tools, and for having indicated that creativity was definitely or probably part of their profession. The 112 participants were administered the survey containing the SUS and CSI (orders balanced and randomized). Two participants failed the attention checks and were excluded from the final analyses. The participants who were clear outliers (either positive or negative) were checked based on the quality of their response in the pre-study and their completion time and they were deemed eligible for inclusion. We invited the participants to join the study sequentially, and excluded them from further participation. First, we invited a few participants for Excel and Word to test the setup, but aimed for 20 participants for each tool as seen in Table 1.

Each participant responded to a total of 40 questions about one of the five software tools. SUS had ten questions, CSI had a total of 27 questions. Three extra questions were asked about Prolific ID, and two attention checks were also asked. Questions from SUS and CSI were contra-balanced to account for ordering effects. The study was completed on average in 6 minutes and 45 seconds. The avg. hourly pay per participant was ~ GBP 10.67/USD 12.75/EUR 11.96.

		Instrument		
Word	Participant 1-10	SUS	->	CSI
	Participant 11-27	CSI	->	SUS
Excel	Participant 28-36	SUS	->	CSI
	Participant 37-50	CSI	->	SUS
Teams	Participant 51-60	SUS	->	CSI
	Participant 61-70	CSI	->	SUS
Photoshop	Participant 71-80	SUS	->	CSI
	Participant 81-90	CSI	->	SUS
Visual Studio Code	Participant 91-100	SUS	->	CSI
	Participant 101-110	CSI	->	SUS

Table 1: Procedure for administering the SUS and CSI instruments

3.2 Participants

In total, 110 participants (M=31.82, SD=9.23 years old) were selected from a pre-study with a sample of 500 knowledge workers recruited through Prolific. To be included in the subsequent study, participants had to fit the following criteria: be fluent in English, use digital technology at work more than once a day, have at least a bachelor/undergraduate (BA) level education, regularly use digital tools to complete work that requires creativity, and indicate that creativity was definitely or probably a part of their profession. Participants represented a range of nationalities, the majority being from Europe (75%), while the remaining participants were from North America (25%). The vast majority (75%) were employed full-time with predominant job titles such as software developers, engineers, project managers, and researchers.

3.3 Measures

3.3.1 Pre-study. The pre-study contained the following questions: 1) What is your profession?; 2)Would you consider being creative an important part of your profession?; 3) What are the three most important software tools for you in your profession?; 4) What is your Prolific ID?

3.3.2 Main study. We introduced both the CSI and the SUS to address measures of creativity support and usability for one of five most important tools. As reviewed in section 2.1 and 2.2, both are commonly available, popular, and relatively simple instruments that yield individual, comparable scores on a 1-100 scale. The surveys asked for the tools' relevance to the participants' general work, not to one specific task. Exact wording of all questions are available in the supplementary material. An attention check was inserted into each of the surveys (e.g., "This is an attention check because we care about the quality of our data. Please tick Strongly Agree"), and the final question asked the participant to provide their Prolific ID number (while retaining anonymity) to pair them with the obtained demographics from the Prolific platform.

3.4 Analysis

In the pre-study, responses contained many sorts of tools (e.g., some mentioned PC, phone, etc.) and suites of tools (e.g., the MS Office package), or they were too unspecific/broad (e.g., "laptop/internet browser") and thus were not included. We identified a list of top-ten tools from which we further selected five tools that we considered different general types of tools. As a case in point, we considered Teams/Zoom or Photoshop/Illustrator, although slightly different applications, to be of a similar "type". We then selected Excel, Word, and Visual Studio Code. We used open-refine[1] to get rid of inconsistencies in e.g. writing/spelling or abbreviations, e.g. Microsoft Word, MS Word, Word, word, Wrod -> Word). To determine the degree of linear association between scores of the SUS and CSI, we ran a Pearson correlation analysis. Descriptive analysis and visual analysis were used to visualize the relationship between the two variables. The analyses were conducted with JASP statistical software[2], and the data is available as supplementary material.

n=26
n=24
n=20
n=20
n=20

4 RESULTS

We first present the results of the empirical findings of the study. We then move on to discussing potential explanations and implications. Looking across the five different tools, the mean scores for the CSI (M=74.36, SD=15.34) and the SUS (M=74.50, SD=15.46) are similar, with some negative skewness as indicated by their distributions in Figure 2. This also mirrors the general empirical data from the SUS as described by [2], who found 208 studies of GUIs to yield similar results (M=75.24, SD=20.77). As mentioned, the same type of data

[1] https://openrefine.org/
[2] https://jasp-stats.org/download/

is not available for the CSI (yet), although the Related Work section provides a few examples of similar scores [1, 7, 38].

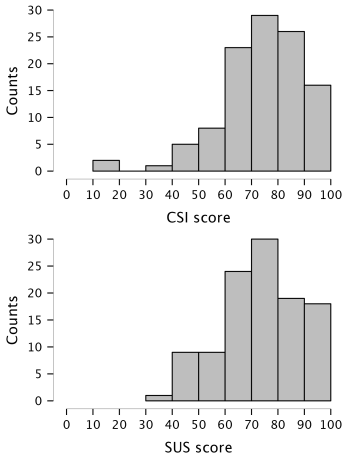

Figure 2: Overall distribution for the CSI and SUS scores

The positive relationship between scores from the SUS and the CSI is illustrated in Figure 3. If we examine the scores of the two instruments across the five tools, a correlational analysis indicates a significant moderate positive correlation (r = 0.524, p < .001, CI [0.373, 0.648]), indicating that tools with high scores on the SUS also tended to score high on the CSI. The moderate positive relationship persists if we consider the clustered nature of our observations into tools using a linear mixed model (r = .599, p <.001).

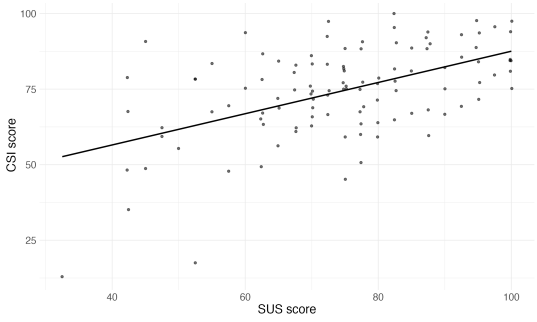

Figure 3: Relationship between CSI scores and SUS scores

4.1 Tool specificity

To identify any differences among the five different tools, we first examined descriptive data separately for the five tools. All the tools, except Photoshop, received what Bangor et al. [2] considered an "acceptable" usability rating. Among the five tools, Photoshop received the lowest usability score (M=63.63, SD=12.53) being the best at supporting creativity (M=79.97, SD=12.32). On the other hand, Teams had a high score on usability (M=83.63, SD=74.01), but a lower score on supporting creativity (M=74.01, SD=11.58).

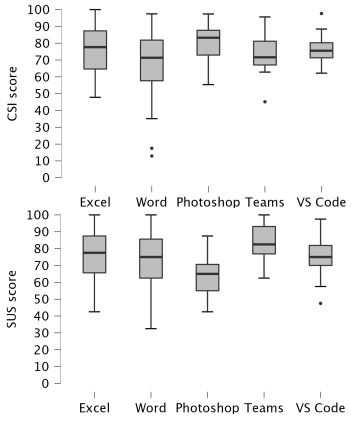

Figure 4: Box plots of individual tools on both SUS and CSI

5 DISCUSSION

5.1 Are usability and creativity support two sides of the same coin?

As highlighted in the Introduction, usability and creativity may appear to be at odds. However, our study demonstrates that usability and creativity appear to be strongly correlated for commonly used, commercially successful software. We speculate that this can be attributed to two general factors. The first concerns the widespread adoption of HCI practices that has made usability testing a common and integral part of product development, including software that supports creative work. The evolution of user interface design frameworks has crystallized best practices, offering guidance and tools for creating intuitive and effective user experiences. The second involves a form of "natural selection" in the marketplace, such that if competing products support creative work to the same extent, but some are more usable than others, users (who are able to freely chose which tools to use for work) will likely gravitate toward the more usable products, which are thus more likely to survive in the long run. Such user behavior may further incentivize companies to prioritize usability as central aim and value in the product development process. Collectively, these factors contribute to the high usability of contemporary digital tools used by knowledge workers engaged in creative work.

If we had chosen to include more specialized or even niche-like tools with a much narrower user group, e.g., Scrivener[3] or vi/Vim [4], in our study, it is possible that we would have observed a wider range of scores for the SUS and CSI as well as more pronounced differences between the two instruments. However, it is important to note that these specialist tools, while potentially yielding valuable insights, would be difficult to study with a reasonable sample size given their niche usage. In addition, multidimensional instruments would also enable a richer analysis of specific aspects of usability.

5.2 Does better usability lead to better CSTs?

From a practical and theoretical perspective, there are several reasons why improved usability may lead to better creativity support.

[3]https://www.literatureandlatte.com/store/scrivener?tab=macOS
[4]https://www.vim.org

An easy-to-use tool reduces cognitive load in use, and it reduces the time it takes to learn how to use the tool in the first place. Consequently, an easy-to-use tool allows time for more exploration and actual implementation of creative ideas. Thus, even if higher usability does not directly lead to higher creative performance in a specific task, it can still free up time that creative practitioners can dedicate to other creative tasks. This implies that one is a prerequisite of the other, much akin to a "hierarchy of needs" for digital tools.

Within the philosophical position of pragmatism [19], we might propose that thinking and doing are intertwined, and that tools to a strong extent mediate human thought and action. For better or worse, tools therefore influence creative processes [9]; not just as a means for realizing ideas that spring from the minds of creative individuals, but also by affecting how ideas are formed in the first place. Examples of this would be how new ideas can emerge through interaction with tools, for instance when musicians start jamming using their instruments, or when designers develop ideas through sketching [6]. In a pragmatist perspective, the correlation between usability and creativity support should be expected. The practical usability-oriented qualities of tools cannot be decoupled from how they influence creative cognition. It is therefore to be expected that tools that are functionally easy to master and use may also yield positive benefits for the perceived creativity of the users.

5.3 Limitations and future work

Since this paper serves as a preliminary study, we consider the contributions to be a) a general discussion of the relationship between usability and creativity; and b) an exploratory, empirical examination of this relationship as it pertains to commonly used digital tools of creative knowledge workers across domains. While this initial study can provide valuable insights into general patterns and identify commonalities between the two concepts, we recognize the limitations of this approach, and we wish to consider how these limitations may be addressed in future work.

Firstly, we chose a broad range of creative professionals to explore the general link between creativity support and usability in digital tools. Future research should focus on specific creative fields to gain deeper insight into this correlation. We speculate that potentially stricter selection criteria for participants from visual arts and writing might challenge or even change the observed relationship.

Secondly, our study is limited by not having data on the specific uses of digital tools by the participants. This might affect our understanding of how these tools support the creative processes of these users. As a case in point, a graphic designer might use Photoshop for creative design and Excel for administrative tasks. However, as argued above, such tools cannot be strictly categorized as either creative or not, illustrated by artists using Excel [21] or PowerPoint [42] for visual art. Such examples not only challenge our conventional perceptions of what constitutes a tool; it also highlights the need for further research to explore nuanced ways through which digital tools support creativity, considering that creative professionals often utilize specific functions of generic tools for various creative stages. Future studies should therefore examine how different tools aid aspects of the creative process within and across various creative domains.

6 CONCLUSION

In this preliminary study, we identified five digital tools that considered important to creative professionals: Word, Teams, Excel, Visual Studio Code, and Photoshop. We then examined using the SUS and CSI in a sample of n=110. We found the degree of linear association between scores of the SUS and the CSI of all scores to be moderately positive, indicating that the theoretical concepts of usability and creativity support are highly overlapping for this set of tools. Although there are differences between the tools, such that one tool may score higher on usability and lower on creativity support (or vice versa), the general correlation between usability and creativity support is clear. We consider the present study a preliminary step toward exploring in more detail the complex relationship between creativity support and usability in the digital tools that so many people rely on when carrying out various creative activities.

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