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Information System Users' Creativity: A meta-analysis of the link between IT use and creative performance

Highlights

- The study explores the effect of information technology on individual users' creative performance.
- The authors link theories of flow and cognitive load to the analysis of creativity.
- Ease of use is found to drive users' creativity by lowering cognitive load.
- A challenging task fosters creativity if the user is immersed in the activity.

ABSTRACT

Purpose – Information technology has been recognized as one of the keys to improved productivity in organizations. Yet, existing research has not paid sufficient attention to how information systems influence the creative performance of individual users.

Design/methodology/approach – This study draws on the theories of flow and cognitive load to establish a model of the predicted influences. We hypothesize that information technology supports creativity by engaging individuals in a creative process and by lowering their cognitive load related to the process. To test these hypotheses, we employ a meta-analytical structural equation modeling approach using 24 previous studies on creativity and information systems use.

Findings – The results suggest that factors that help the user to maintain an interest in the performed task, immerse the user in a state of flow, and lower a person's cognitive load during information system use can affect the user's creative performance.

Research implications – Our findings imply that a combination of the theories of flow and cognitive load complements the understanding of how information systems influence creativity.

Originality/value – This paper proposes an explanation on why information systems affect creativity, which can be used by scholars to position further research, and by practitioners to implement creativity-support systems.

Keywords: Creativity, Cognitive Load Theory, Theory of Flow, Structural Equation Modeling, Meta-analysis

1 INTRODUCTION

In the early 1990s, it was hard to believe that computers could achieve such a tremendous success in replacing activities previously done by humans. However, creativity is a different process, and up to now computers have not been able to substitute for people in this arena. Yet, the use of computers as an aid in the user's creative processes is well recognized in the literature (cf., Edmonds et al., 2005). Hence, it is important to understand how technology affects individual users' creative performance.

More than twenty years of empirical research has established that technology can augment individual users' creativity (Muller and Ulrich, 2013; Seidel et al., 2010). A critical perspective on the possibilities of advancing creativity might scowl at the idea that creativity is inherently human and that no information technology can be brought into the process. However, technology has been closely linked with the creative process for some time, whether in Pasteur's microscopes and beakers or Leonardo's paint and canvas. Moreover, Shneiderman (2000) suggests that supportive technologies can play an important role in creative work, just as the potter's wheel and mandolin do for artistic endeavours. In practice, technology may produce new means of expression by enabling more compelling performances. Creativity consultants have the same opinion; according to Burroughs and colleagues (2011), only 6% of individuals' creativity depends upon the persons themselves—the other 94% depends on the process and the supporting systems. Moreover, Shneiderman (2000) argues that creative people often benefit from advanced use of technology that raises their potential and ability to explore new domains.

The role of technology as an enhancer of creativity has been accepted by many researchers (Khalil, 1996; Martins and Terblanche, 2003). However, an explanation of why and how IT affects creativity is still missing. Seidel et al. (2010) conducted an extensive review of the literature on information systems (IS) related to creativity and found that IS has been treated as a black box in terms of its relationship with creativity. Seidel and colleagues (2010) encouraged the field to tackle this issue, and urged for further research to improve the understanding of how technology affects creativity in order to augment the design and implementation of creativity support systems. In this study, we investigate information systems from the user's perspective to improve the understanding of how to support users in their creative pursuits.

We pose the following research question: *How does information systems use influence the creative performance of individuals in a creative work process*? To address this question, this study proposes a conceptual model that incorporates two theories—flow and cognitive load. Based on these two theoretical perspectives, we establish a number of hypotheses on the factors that influence the user's creative performance. The hypotheses are tested using structural equation modelling in a meta-analytical research setting, which utilizes the findings of 24 previous studies of creativity and information systems as a sample dataset.

This study is structured as follows. After this brief introduction, the upcoming section reviews recent works on the links between creativity and IS use. Thereafter, we describe the main concepts of the study and form testable hypotheses. In the remaining sections, we describe our method used to test the model, present the results, and discuss the implications of the study for research and practice.

2 THEORETICAL BACKGROUND

Creativity has been an area of perennial interest to the IS research community. It is widely discussed in entrepreneurship, management, psychology, human resources disciplines, and also in the area of information systems. Researchers have been especially interested in how different tools, particular types of motivation, and different environments affect individual or group creativity.

Creativity by itself can be considered to be the production of something that is both original and useful (Amabile, 1996). The word ''creativity'' relates to concepts such as novelty, innovation, and originality (Edmonds et al., 2005). Martins and Terblanche (2003) define creativity as the "*generation of new and useful and valuable ideas for products, services, processes and procedures by individuals or groups in a specific organizational context.*"

There are various prerequisites found for increasing one's creativity. Woodman et al. (1993) found that an individual's creativity is influenced by cognitive style, knowledge, personality, and intrinsic motivation. Khalil (1996) mentioned four elements for an environment that is conducive to creativity. These are: access to relevant information, intrinsic motivation, memory, and the transferability of problem-solving experiences. Technology, which includes gathered knowledge of individuals and the availability of facilities (e.g., a computer, the Internet), is considered to be one of the various determinants that support the creative process (Martins and Terblanche, 2003).

Recent research streams formed several areas that aim at studying creativity and its facilitation with technology. One line of thought is aimed at individual attributes that make a person creative, and according to which they can be classified (Muldner and Burleson, 2015). Another stream aims at proposing and understanding how to design collaboration technology, generally called ICT, and the influence of such technology on the user's creative behavior (Elerud-tryde and Hooge, 2014; Karakaya and Demirkan, 2015; Van Rosmalen et al., 2014; Wook et al., 2015; C. Zhou et al., 2014) and the role of IS in the development of one's creativity (Bonsignore and Quinn, 2013; Jackson et al., 2012). One more research area looks at the creative use of IT (Wang et al., 2013). The integration of external knowledge into the creative process has also received considerable research attention (Chang et al., 2014; Dennis et al., 2013; Jenkin et al., 2013; N. Kim et al., 2013; Ren et al., 2014; Tang, 2014). Additionally researchers have emphasized various types and aspects of feedback in creative-process facilitation (F. Chen et al., 2014; Hildebrand et al., 2013), recognition of creative solutions within virtual environments (Jensen et al., 2014), individual mental aspects (Nguyen and Zeng, 2014), and creative tasks and goals formulation (Fabricatore and López, 2013; Gong et al., 2013).

Studying the impact of technology in facilitating creativity at the individual or group level has become the most researched creativity area in the IS research (Muller and Ulrich, 2013). The IS literature in this area has adopted key concepts from psychology and management literatures. There is the belief that creativity can be enhanced by external factors, such as environment, reward systems, and training, as well as through support from tools and techniques (Couger et al., 1993; Muller and Ulrich, 2013). There are at least four general streams of research dealing with the links between creativity and IS (Cooper, 2000; Muller and Ulrich, 2013). One line of thinking relates to techniques and software tools for skill enhancement for an individual. Another focuses on implementation of these techniques and tools within organizations. A third stream is interested in how creativity contributes to systems and their management. The fourth stream focuses on the evaluation of creative activities, products, and services of IS organizations (Muller and Ulrich, 2013).

There is an area, however, that remains noticeably unexplored, and which concerns the capability of information systems to augment creativity by helping to store, retrieve, combine, manipulate, and transmit information. According to Orlikowski and Iacono (2001), these capabilities have the potential to support the processing, modelling, and simulation of a variety of aspects of the world. Orlikowski and Iacono (2001) adopted a computational view of the technology-creativity link, which takes into consideration person-related variables such as cognitive style, knowledge, and personality factors of the individuals using the system, as well as environmental factors (Seidel et al., 2010).

Creativity is also subject to an individual's abilities, and the extent to which system attributes can enhance and evoke an individual's creative performance is restrained by this (Avital and Te'eni, 2009). An environment provided by IS can lead to more novel and useful ideas, compared to paper-and-pencil approaches

(Doll and Deng, 2011). Creativity involves highly chaotic and complex processes, which IS can transform to a more manageable form (Muller and Ulrich, 2013). Greene (2002) suggests that information technology has the potential to support creativity in a variety of ways, and can do this on at least two distinct levels. First, it can be directly applied as tools in a creative process facilitated by computer-aided design of products. Second, knowledge management systems can assist creative individuals in exploring, collecting, sharing, and integrating knowledge during the process of generating creative ideas. From the IS point of view, van der Heijden (2004) proposed that IS can be used for two types of outcomes—pleasure related and usefulness related. Based on these aforementioned propositions, we will build our hypotheses in the following section.

Creativity support systems can be categorized by whether they support groups or individuals in their creative work (Müller-Wienbergen and Müller, 2011). In this paper we focus on the individual-focused systems. Because creativity support systems are expected to have common components across several domains of creative work (Hewett, 2005; Voigt et al., 2012), the aim of this study is to investigate the effects of IT use for a wider variety of tools. Therefore, the IS supporting creative work will be treated as general creativity support system, rather than a single type of an information system.

In particular, a creativity-supporting information system is considered in this study as an IT system that can support individuals in developing creative ideas and conducting creative work. More precisely, to employ various creativity techniques in order to guide the user through the idea development process and provide stimuli aimed at developing new ideas and conducting tasks that require creativity; for instance, providing visual and spatial cues for the users in the form of examples or information in order to help develop an idea, with the clearly stated aims as targets that need to be reached.

Since creativity support systems eventually aim at fostering the production of creative outcomes (Voigt et al., 2012), we chose creative performance as the measurement of individual creativity.

2.1 The influence of IT on creative performance

Amabile (1983) suggests that the existence of a problem to be solved may stimulate creativity, as curiosity aroused towards the problem may get individuals engaged in the process as they continue searching for a solution. Such challenges may lead individuals to search for novel ways to overcome the experienced problems. However, a problem is not a prerequisite for creative performance. Rather, it is shown as some sort of stimuli, which is useful in order to facilitate idea generation.

Conversely, IT artifacts may serve creative performance by advancing higher order tasks (Davern et al., 2012). Human interaction with computers can be fundamentally considered to be a human activity of communication based on a flow of information; e.g., commands and messages from the users to the computer and back to the user. Such a human-computer interaction is used for generating, using, and manipulating representations. Representation of information has been important from the early studies in IS. It has been suggested that representations of information through an information system can affect users' cognition, their beliefs, and continuous usage of the system (Dimoka, 2010; Kjærgaard and Jensen, 2014). Additionally, it has been shown that representation may enhance users' IS skills, or get them to experiment with IS (Eschenbrenner and Nah, 2014). According to Kim et al. (2000), users that rely upon visual cues and contextual information can construct more comprehensive mental representations and thus increase their problem-solving performance. The development techniques are typically embedded as representations; thus, simulating different type of presentations gives different outcomes for a developer (Davern et al., 2012). Moreover, it is shown that IS can make both cognitive and affective changes to the users, especially in the context of online shopping (Koufaris, 2002; Pavlou, 2003; van der Heijden, 2004).

Information systems can be categorized roughly into two groups—utilitarian and hedonic. Whereas the former relates to productivity-oriented systems, the latter is pleasure oriented (van der Heijden, 2004). Hedonic IS systems achieved a lot of attention in the past few years. Gamification, especially, became a trend within the IS area (Hamari et al., 2015). This refers to the process where game elements such as badges, reputation points, or leaderboards are applied in non-gaming settings (Hamari et al., 2014). In other words, users get tasks or goals, and after achieving them receive a reward in the form of badge or reputation points, which facilitates climbing up on the leaderboard or out-rivaling other users. Therefore, the experiences of using an IS can be designed by incorporating tasks, rewards and a competitive environment the ways they are used, for example, in video games. Cognitive literature also recognized the importance of task attributes for successful problem solving (Paas and Van Merriënboer, 1994). A challenging task can force a user to set a goal and seek it, and in this sense guide but also restrict the performance. Users, by themselves, tend to prefer less restrictive IS used for decision support (Wang and Benbasat, 2009); however, findings show that users of more restrictive systems might outperform those relying upon less restrictive systems (Davern and Kamis, 2010).

H1: Task-related challenges have a direct effect on information technology users' creative performance

While hedonic aspects of IS are important in users' delivered outcomes, providing systems that satisfy an individual's desires will not have a large effect on either the efficiency or the effectiveness of the problem solving (Vessey and

Galletta, 1991). Therefore, utilitarian aspects need to be incorporated into the system as well. Utilitarian systems was the leading area of research from the emergence of the IS area. A majority of which concentrated on users' intentions to use such IS. One of the key input variables that was shown to have an impact on users' attitudes and intentions to use information systems is perceived ease of use (Davis, 1989). Decision-making literature suggests that effort is an important factor influencing users' choice and their intentions to use decision aids (Payne, 1982; Todd and Benbasat, 1999). Van der Heijden (2004) suggests that perceived ease of use should play a more central role in predicting user acceptance of pleasure related to IS. Therefore, we hypothesize:

H2: Perceived ease of use of information technology positively affects users' creative performance

Based on the above-reviewed studies on the information technology users' creative performance, these two hypotheses form the main linkages between IT use and users' creative performance. Yet, previous research has not explained their effects simultaneously. Moreover, there are numerous studies showing that users' flow experience and perceived cognitive load may significantly influence these effects. Hence, the present study takes a closer look at these relationships between IT use and users' creative performance.

2.2 Theory of flow

The term 'flow' is adopted by Csikszentmihalyi (1990) because this word is repeatedly used by dancers and rock climbers to describe the sensation they feel in the middle of an optimal experience. According to Csikszentmihalyi (1990) and Finneran and Zhang (2005), flow represents a state of consciousness where a person is involved in an activity without consciously being aware of his or her every movement. People in a state of flow experience a loss of self and forget their everyday concerns temporarily. They perceive time differently than normal, with time generally seeming to fly by while the person is engaged in the activity (Guo and Klein, 2009).

The theory of flow, developed in the reference discipline of psychology, provides a theoretical lens for understanding human behavior in a variety of task contexts (Guo and Klein, 2009). This theory has been applied in a broad range of contexts such as sports, shopping, rock climbing, dancing, gaming, and others (Wang and Scheepers, 2012). However, optimal experience can occur not only in the pursuit of physical activities, but also in interactions with symbolic systems such as mathematics and computer languages (Agarwal and Karahanna, 2000). It is used to address optimal user experiences with personal computers (cf., Ghani and Deshpande, 1994) and the Internet (e.g., Hoffman and Novak, 1996; Novak et al., 2000). Since the late 1980s, information technology researchers have used the theory of flow to explain the usage of software, such as email, the Internet, e-learning, and online shopping (Guo and Klein, 2009). While the concept of flow is well known in various fields, there are other user-engagement-describing concepts that relate to flow. Studies showed the conceptual similarity between the state of absorption and the flow experience (Agarwal and Karahanna, 2000). Other studies noted that a state of playfulness is identical to the flow experience (Webster and Ho, 1997).

Flow theory conceptualizes the flow experience as something that happens in stages rather than all at once (Lowry et al., 2013), and it is characterized by common elements: (1) a challenging activity that requires skills, (2) merging action of awareness, (3) clear goals and immediate feedback, (4) concentration on the task at hand, (5) sense of control, (6) loss of self-consciousness, (7) transformation or distorted sense of time, and (8) self-rewarding or autotelic experience (Nah et al., 2011).

The notion of flow is an important element of understanding human technology interactions, and indeed, an important antecedent of attitudes toward technologies (Agarwal and Karahanna, 2000). Csikszentmihalyi (1975) argues that human performance is enhanced when a person enters into a state of flow. Studies show that perceived flow would result in several outcomes, such as a positive experience, increased learning, perceived behavioral control, focus on process, changes of attitude, exploratory mindset, and creativity (Agarwal and Karahanna, 2000; Finneran and Zhang, 2005). Research on serious games shows that learning becomes more enjoyable when game-type features are applied; they capture a person's attention, challenge their curiosity, and thus enhance their interest in the theoretical knowledge (Boughzala, 2014). Additionally, it is reported that flow is positively related to purchase intention and return intention in Web usage, repetitive play behavior and intention to play, perceived ease of use and perceived usefulness, and satisfaction (Agarwal and Karahanna, 2000; Guo and Klein, 2009).

In a computer-mediated environment, the influences of the activity—or task-related challenges—are unclear. Using the IS does not by itself demonstrate a clear goal. For instance, the IS could be used for finding and processing specific information, or for enjoyment, such as, for example, playing a particular game. In this case the actual activity would be the combination of using the IS and the specific tasks related to the activity.

Deconstructing the task and setting goals to accomplish, lead users may be able to develop successful solutions as shown in physics as well as in computer-programming problems (Paas and Van Merriënboer, 1994). The goal of these solutions can be attained only by successfully attaining all sub goals. A computer-mediated environment in this case can do two jobs. Firstly, it can deliver specific goals, a path that the user needs to follow, and in this case set a challenge. Such a notion is called machine interactivity (Hoffman and Novak, 1996). Secondly, it can influence the user's likelihood to stay focused on the underlying task (Finneran and Zhang, 2005).

The flow experience is happening while a person is doing an activity (Finneran and Zhang, 2005). As mentioned before, resolving challenges, which are balanced with your skills, may lead to immersion or flow. Therefore, we can argue that if the IS creates a challenging environment, a person will immerse into the state of flow. Hence, we hypothesize:

H1a: Task-related challenges have a direct positive influence on an individual's immersion into the state of flow.

For a creative response to emerge, an individual must engage in creative activities, such as problem identification, environmental scanning, data gathering, unconscious mental activity, solution generation and evaluation, and solution implementation (Zhang and Bartol, 2010). If cognitive processing is interrupted, then critical information will not have been accessed or used in problem solving, which results in low creativity as an outcome (Shalley, 1995).

Simon (1967) indicated that the primary function of intrinsic motivation is the control of attention. Such attention directs people to engage in a creative process through self-regulation. Intrinsic motivation reflected by benefits derived from the activity itself (e.g., pleasure from playing games) has been shown to have a higher impact on creativity (Grant and Berry, 2011), and more importantly is superior to describe usage of a pleasure-based, or hedonic, IS (Lowry et al., 2013; Wu and Lu, 2013). Shalley et al. (2009) showed that individuals who are highly motivated intrinsically are inherently interested in what they are doing and experience satisfaction and enjoyment from working on their tasks. Intrinsic motivation is closely related to playfulness (Venkatesh, 2000) and flow (Zhang and Bartol, 2010), and the capacity to treat work as play characterizes successful adult learners and problem solvers. Research suggests when students are at play they will spend more time and effort at learning, will enjoy what they are doing more, will be more likely to use what they have learned, and will learn more effectively (Webster and Martocchio, 1992). Moreover, playfulness relates positively to individual creativity and to more exploratory behaviors during interactions with tasks, as well as overall enhanced task performance (Webster and Martocchio, 1992).

If these outcomes extend to creativity-related situations, users who interact more playfully with the IS will be more likely to put effort into learning the system, will demonstrate more exploratory behaviors, and thus will manage features that the IS provides and be ready to incorporate them in building creative solutions. Researchers believe that such deep involvement and playfulness is critical to creativity (Elam and Mead, 1990; Kaye and Little, 1996). Based on this we can argue that if the systems build an environment that is challenging, and the individual becomes interested in the activity itself, the individual will become immersed into a creative process and perceive a flow experience, which at the end will boost their creativity. Hence, we hypothesize:

H1b: Flow experience has a direct positive influence on an individual's creative performance.

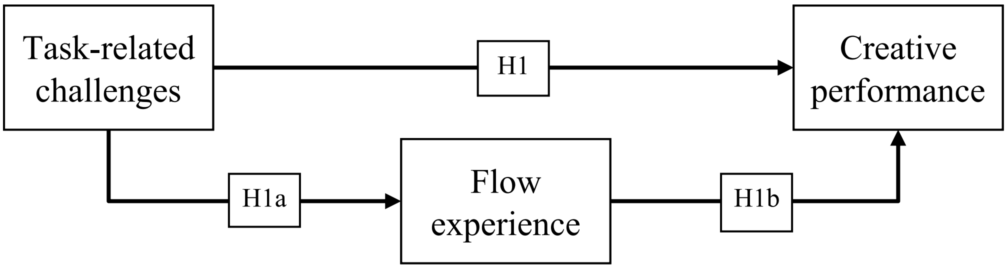

Figure 1 Hypothesis 1 (with H1a and H1b)

Taken together, chain mediation effects will occur between the perceived challenges and individual creativity. To understand the relationships comprehensively, we will need to work out the role of the mediating factors in these relationships. In sum, Hypothesis 1, depicted in Figure 1, proposes that challenges may foster creativity, but flow experience mediates the relationships between the perceived challenges and individual creativity.

2.3 Cognitive load theory

Human-computer interaction is not always gratifying. It can also lead to stress. Riedl et al. (2012) measured the level of stress hormone for computer users and showed that a computer system's behavior can increase a user's stress level. A creative problem-solving process involves a series of distinct mental operations (e.g., collecting information, defining problems, generating ideas, developing solutions, and taking action) (Adams and Avison, 2003). The user must use appropriate processes, and thus develop appropriate mental representations, for performance effects to occur (Vessey and Galletta, 1991). Cognitive effort spent by the user is believed to be critical in determining what is suitably designed (Gregor and Benbasat, 1999). IS can and should be designed to ease the demands on cognitive resources and consequences of memory overload (Olson and Olson, 2000).

Cognitive load theory is based on the notion that human problem solvers are limited information processors and will seek ways to reduce their problem-solving effort (Vessey and Galletta, 1991). Information is being stored and processed by short-term and long-term memories. Information enters the human information processing system through a variety of channels associated with the different senses. Initially it is processed into short-term memory, and either stored into the long-term memory or forgotten (Alasraj et al., 2011). Short-term, or in other words working memory, works as a momentary storage of information that is processed to perform cognitive tasks, whether information comes from outside or from long-term memory itself.

While rather unlimited amount of information can be stored in the long-term memory, short-term memory has much stricter limitations. It is acknowledged that this type of memory has the capacity of seven plus or minus two “chunks” of information, with a duration between 18 to 20 seconds (Alasraj et al., 2011; L. Peterson and Peterson, 1959). When the amount that needs to be stored and processed in the short-term memory exceeds memory limitations, learning processes become ineffective (Sweller, 1988).

However, the amount of occupied short-term memory—or cognitive load—can be reduced. In order to reduce processing effort, the aim is to facilitate the processes that human problem solvers use in completing a task (Vessey and Galletta, 1991). The human information processing system consists of separate channels for different kinds of information, e.g., verbal and visual. Only a limited amount of cognitive processing can take place in each channel at one time. Meaningful learning requires a substantial amount of cognitive processing to take place in information processing channels (Mayer and Moreno, 2003). Therefore, working memory architecture and its limitations should be a major consideration when designing instructions (Paas et al., 2003).

Cognitive load is a combination of at least two quite separate factors: intrinsic cognitive load related to the processing of information, and extraneous cognitive load, which is imposed by the representation of information (Sweller, 1988). Additionally, there is a third type of cognitive load, called germane load. This type of load comes from connecting new information with previously learned information (Paas et al., 2003). However, there is an ongoing discussion regarding whether germane load can be manipulated or measured, and whether it should be considered as a part of intrinsic cognitive load (Kalyuga, 2011).

Intrinsic cognitive load relates to the instructional topic itself. It is the amount of load on working memory, which depends on the extent to which individuals are experienced with the specific topic and how well the material is presented. Additionally, this type of load is related to the processing of schemas and learning—in other words, connecting new information with what the individual already knows (Kalyuga, 2011; Paas et al., 2004). This type of load depends on the individual itself and how experienced he is within a particular area and learning process. This type of load can not be influenced by the type of user interface (Sweller, 1988).

Extraneous cognitive load, on the other hand, can be manipulated by different types of presentations. This type of cognitive load is generated by the manner in which information is presented to learners; for example, by text or visual representation, or both (Chandler and Sweller, 1991). The fewer cognitive resources needed to understand what the instructor is presenting, the less extraneous cognitive load is generated. Cognitive load is a central consideration in the design of multimedia instructions (Mayer and Moreno, 2003). Findings show that extraneous cognitive load can be reduced by changing one type of presentation to another (e.g., from textual to visual) or combining them, thus leaving enough resources to absorb presented information (Paas et al., 2004).

As the choice set size increases, users start to be constrained by their cognitive limitations because of bounded rationality (Kamis et al., 2008). Without the help of information technology, users may resort to heuristics and other simplification strategies, even ones that they themselves view as suboptimal (Speier and Morris, 2003). Hence, IS can enhance performance by reducing the effort required (Davern and Kamis, 2010).

Research has shown that users readily adopt information technologies to reduce their cognitive workload and improve their decision-making efficiency, which results in higher levels of decision satisfaction (Kamis et al., 2008; Todd and Benbasat, 1991). For instance, Jarvenpaa (1989) reports that information acquisition is based principally on the presentation. On the other hand, the IS can also be a distraction due to its richness (Nah et al., 2011). Research on the hedonic IS stresses the importance of perceived ease of use. When the hedonic IS is difficult to use, the interaction with the system becomes the focus of the activity and, therefore, detracts from the outcome (Lowry et al., 2013; Z. Wang and Scheepers, 2012). For instance, if a game is low in perceived ease of use, the player will more likely become frustrated, grow apathetic, and cease to devote attention to the game, causing a loss of curiosity about the game. If a game is easy to use, a player's attention is free to explore and become excited about the "available possibilities" of his or her interaction with the game (Zhang et al., 2006).

We argue that in order to concentrate on acquiring new information, individuals should not perceive additional challenges, especially in terms of understanding IS usage itself, or in discovering the possibilities that an IS may bring on. In other words, a system should be easy to use and assist the user in performing the task the user is devoted to. Ease of use was discovered as one of the most important variables in determining whether a person will be willing to use some kind of technology or not (Davis, 1989).

H2a: Ease of use of an information system is associated with less cognitive load for the user.

Individuals need working memory to process new information. This is the part of our mind associated with our consciousness. This working memory also assists in solving problems and in being expressive. Hence, during complex learning activities in which information and interactions must be processed simultaneously, working memory can be either under-loaded or overloaded (Paas et al., 2004).

Working memory can store and process no more than a few discrete items at any given time. Though, schema acquisition may enhance or even by-pass this restriction (Sweller, 1988). Cognitive schema can be conceptualized as cognitive structures that enable problem solvers to recognize problems as belonging to particular categories requiring particular operations to reach a solution (Paas and Van Merriënboer, 1994). In other words, schema is a web connecting various learned concepts. It can be used by mapping processes to reach solutions for unfamiliar aspects of the problem-solving task (Paas and Van Merriënboer, 1994). Schema is acquired when an individual connects new information with the knowledge that is stored in the long-term memory.

Experts have acquired tens of thousands of schemas, which are the building blocks of intellectual skill (Sweller, 1988). Acquired schemas can be used in solving new problems, and a sequence of varied examples and problems enhances the transferability of the acquired knowledge structures (Paas and Van Merriënboer, 1994).

However, in order to acquire new schema, an individual first needs to be able to process the provided new information. A major reason for the ineffectiveness of problem solving is that the cognitive processes required by the two activities overlap insufficiently, and that conventional problem solving requires a relatively large amount of cognitive processing capacity, which is consequently unavailable for schema acquisition (Sweller, 1988). For example, Sweller (1988) has demonstrated that mean-ends analysis, often used by novice problem solvers, consumes a large amount of the learner's limited cognitive capacity, partly for processes that are not directly relevant for learning; these processes are associated with so-called extraneous cognitive load (Paas and Van Merriënboer, 1994). An overloaded working memory limits the ability to connect new information with previous knowledge, which is a key part of developing creative ideas.

Methods and tools can be used to efficiently use people's limited cognitive processing capacity to stimulate their ability to apply acquired knowledge and skills to new situations (Paas and Van Merriënboer, 1994). Information technology (e.g., knowledge management systems) can assist individuals in creative processes in exploring, collecting, sharing, and integrating knowledge (Greene, 2002; Seidel et al., 2010). In other words, IS can help an individual to be more creative through the support provided by information management.

While a new task can be solved through the use of schemas, schema acquisition will be established only if extraneous cognitive load is reduced (Paas and Van Merriënboer, 1994). Thus, we hypothesize:

H2b: Cognitive load has a direct negative influence on creativity.

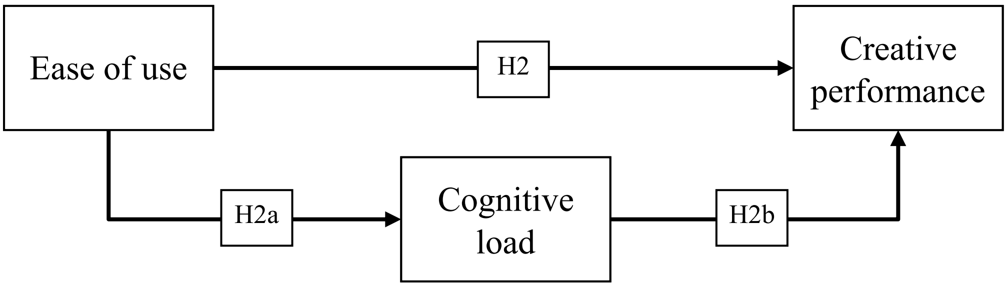

Figure 2 Hypotheses 2 (with H2a and H2b)

A chain mediation effect occurs in the relationship between information technology use and user's creativity. The easier a system is to use, the lower the amount of extraneous cognitive load for a user, and the more cognitive resources that are left for the task itself, thus the better the individual creative performance. In other words, the easier a system is to use, the less cognitive resources this will occupy, and the more information a person can assimilate, which will lead to higher creativity. Hence, Hypothesis 2, depicted in Figure 2, proposes that ease of use may foster creativity, but cognitive load mediates the relationship between the perceived ease of use and individual creativity.

In addition, previous research suggests that cognitive support could help learners to concentrate on the learning materials (Shen and Chu, 2014). This is important from the perspective of our study, as concentration is considered one of the prerequisites for experiencing flow. The findings of Shen and Chu (2014) indicate that, for example, when learners do not waste their time on searching for information, they focus on learning. In this sense, the ease of use of an IS may increase flow experience. In practice, simple rather than complex systems may contribute to the ability to concentrate on the provided material. Thus, when interactive activities do not overcrowd one's cognitive load, they can result in more fun and more effective learning (Wang and Tseng, 2014). Therefore, we hypothesize:

H3: Cognitive load has a direct negative effect on flow experience.

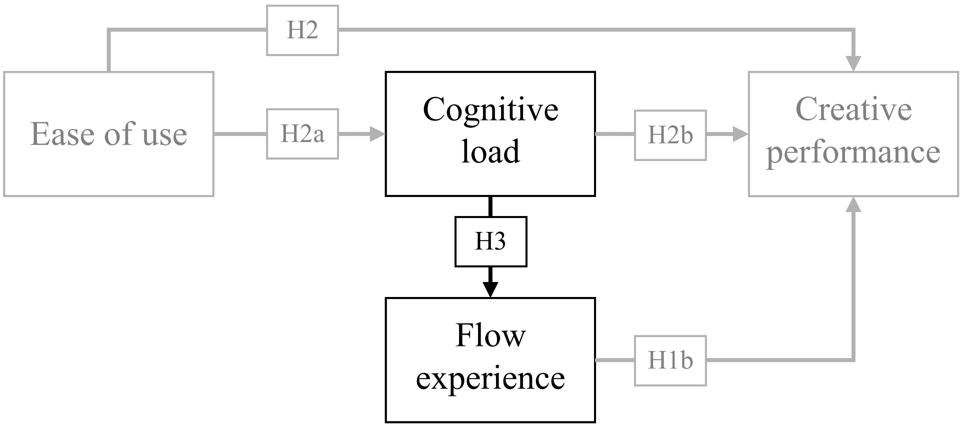

Figure 3 Hypothesis 3

Combined, the baseline model includes five hypotheses, which we test through meta-analytical structural equation modeling.

3 METHODS

Douglas and Craig (1992) suggested that strong theoretical and conceptual frameworks can be developed through an integration of constructs from different research traditions and disciplines. Chen (2003) noted that the integration of theories "builds bridges" between different theories and should be developed for specific contexts.

3.1 Meta-analysis

Meta-analysis is the methodology of choice to synthesize existing empirical evidence and draw science-based recommendations for practice in the organizational sciences and many other fields (Aguinis et al., 2011). It is proven to be a popular statistical technique in many disciplines including educational, social, and medical sciences (Cheung, 2015, p.2). There are examples of meta-analysis in some specific areas of information systems research as well (e.g., DeRosa et al., 2007; King and He, 2005).

This approach can be understood as a form of survey research in which research reports, rather than people, are surveyed—"a coding form (survey protocol) is developed, a sample or population of research reports is gathered, and each research study is 'interviewed' by a coder who reads it carefully and codes the appropriate information about its characteristics and quantitative findings" (Lipsey and Wilson, 2001, p1). Meta-analysis goes beyond a literature review, in which the results of the various studies are discussed, compared, and perhaps tabulated, since it synthesizes the results of the individual studies into a new result (Berman and Parker, 2002). Although there has always been some controversy about its validity, meta-analysis was proven to be a successful technique, as the number of studies with similar protocols has grown (Berman and Parker, 2002).

Meta-analysis applies only to empirical research studies that produce quantitative findings, i.e., studies using quantitative measurement of variables and reporting descriptive or inferential statistics to summarize the resulting data. Therefore, it cannot be used to summarize theoretical papers, conventional research reviews, policy proposals, and rules out qualitative forms of research such as case studies, ethnography, and "naturalistic" inquiry (Lipsey and Wilson, 2001, p2). The dual goals of a meta-analysis are to (a) estimate the overall strength and direction of an effect or relationship, and (b) estimate the across-study variance in the distribution of effect-size estimates and the factors that explain this variance (Banks et al., 2012; Berman and Parker, 2002).

Meta-analysis has several advantages over other methodologies (Lipsey and Wilson, 2001, p5). Meta-analysis procedures impose a useful discipline on the process of summarizing research findings, it represents study findings in a manner that is more differentiated and sophisticated than conventional review procedures, and it provides an organized way of handling information from a large number of study findings under review (Lipsey and Wilson, 2001, p5). However, what is more valuable, especially for this research, is its ability to synthesize effect estimates with considerably more statistical power as compared to individual studies (Lipsey and Wilson, 2001, p6). This is important, as ''scientists have known for centuries that a single study will not resolve a major issue. Indeed, a small sample study will not even resolve a minor issue. Thus, the foundation of science is the cumulation of knowledge from the results of many studies'' (Hunter et al., 1982, p10). Specifically, creativity was widely researched within the IS area, as well as other fields of social science (Muller and Ulrich, 2013). Therefore, it provides a great environment to apply the meta-analysis approach.

The thoroughness of meta-analysis is dependent on these four keystones: formulating the study question, identifying research studies, collecting and evaluating information about these studies, and extracting results (Berman and Parker, 2002).

3.2 Sample and coding

The performed data collection process followed the process of a typical systematic literature review. The main difference between such a review and a meta-analysis is in the analysis phase, where effect sizes are explicitly calculated and synthesized in a meta-analysis (Cheung, 2015, p.48). The search process consists of two parts—finding bibliographic references to potentially eligible studies, and obtaining copies of those studies to screen and, if eligible, to code for inclusion in the meta-analysis (Lipsey and Wilson 2001, p.24).

Meta-analysis should begin with a careful statement of the topic to be investigated or the question to be answered, which will drive the selection of the study and analysis of the results (Lipsey and Wilson, 2001, p.12). As our intention is to understand how IS can influence an individual's creativity, we therefore aimed at locating IS studies related to creativity. To reduce possible noise we performed the search process mainly within the IS area.

Lipsey and Wilson (2001, p.25) suggested including review articles, references in studies, computerized bibliographic databases, bibliographic reference volumes, relevant journals, conference programs and proceedings, authors or experts in the area of interest, and government agencies into a comprehensive search. Out of these suggestions we neglected searching within bibliographic reference volumes, due to the reason that each of the volumes of the journals could be accessed within electronic databases. Additionally, we did not contact authors or experts, or government agencies. One of the main reasons is a lack of such practices within the social science field while conducting meta-analyses or systematic literature reviews.

Overall, 24 relevant studies were located and further analyzed. The search process with the outcomes is displayed in Table 1. As suggested by Lipsey and Wilson (2001 p25), we started this research with a literature review article on creativity within the IS field (e.g., Seidel et al., 2010) and examined references used in this article. Further, we performed a search within electronic databases with the keyword "creativity". First, a search was conducted within the IS studies database aisel.aisnet.org, and peer-reviewed journals as well as conference papers were examined. The database included only conference papers from 2011 and earlier. Therefore, we manually searched three conferences proceedings that provided most of the yield in the "Aisel" database—ICIS, ECIS, and AMCIS within the google.scholar.com database, with keywords "ICIS creativity", "ECIS creativity", and "AMCIS creativity". Additionally, we examined peer-reviewed articles from references lists that were found in several extensive literature reviews, namely Muller and Ulrich (2013), Dean et al., (2006), and DeRosa et al., (2007). The search was performed within the FT45 list of journals as well.

An unexpected challenge arose due to the complete absence of studies that investigate the relationship between *flow* and *cognitive load* concepts, and that relate to creativity and IS. This caused a threat to our study as it forbade us from fully investigating the model. Therefore, we attempted to collect studies investigating *flow* and *cognitive load* not necessarily related to creativity. To search for *cognitive load* and *flow* studies we used the aisel.aisnet.org and google.scholar.com databases. First, we used the keyword "'flow' 'cognitive load'", however, the word "flow" in the keyword yielded lot of noise referring to text flow, traffic flow, blood flow, and little towards our target. Therefore, we replaced it in the search phrase with the flow concept inventor's name—"Csikszentmihalyi".

Table 1 The search process.

Publication type	Search term(s)	N	Source
Review articles	"Creativity"	2	Seidel et al., 2010
		0	Muller et al., 2013
		1	Dean et al., 2006
		0	De Rosa et al., 2007
The Aisel database	"Creativity"	5	Journals
		4	Conferences
IS conference papers	"Creativity"	3	ICIS
		0	ECIS
		1	AMCIS
Flow and cognitive load literature	"Cognitive load",	1	Aisel database
	"Csikszentmihalyi"	4	Google Scholar
FT45 journal publications	"Creativity"	3	http://www.ft.com/ (2012, February)
Total		**24**	

In Table 1, quotes indicate the search terms used, source indicates the main sources of data, and N indicates the number of relevant studies found per search criteria.

3.3 Inclusion and exclusion

After locating creativity- and IS-related studies, the next step was to include or exclude them from the analysis. Inclusion and exclusion criteria for studies are necessary in a meta-analysis. The criteria should follow immediately from the objectives of the study (Berman and Parker, 2002). Lipsey and Wilson (2001, p16) proposed general categories for study eligibility criteria: (a) distinguishing features of the qualifying study, (b) research respondents, (c) key variables, (research) designs, (d) cultural and linguistic range, (e) time frame, and (f) publication type. We chose only studies that (a) researched the IS and creativity link, except studies investigating both cognitive load and flow concepts, (b) we included studies on all respondent groups, but we coded for this factor, (c) included only studies that investigated variables that our model contains, (d) were written in English, (e) were written during the time frame that the IS field exists, and (f) were published only in peer-reviewed journals and conference papers. Coding was done by one author.

Berman and Parker (2002) suggests that a quick review of the abstracts of the papers will eliminate those that are clearly not relevant to the meta-analysis or do not meet other criteria. However, we noticed that reviewing abstracts in the IS field might not be sufficient enough, as the majority of articles do not explicitly mention either the methodology or variables that were studied. Therefore, each of the peer-reviewed articles that was returned based on the keywords was briefly read in order find evidence of being suitable for the study. If an article possessed hints—e.g., exploring creativity with the angle of IS, and using the quantitative method—it was analyzed more thoroughly. An article was dismissed from further analysis if it fell into one of the following groups: (1) was a qualitative study or purely conceptual study, (2) analyzed creativity at the group level rather than individual, (3) used variables not of particular interest to our study, (4) analyzed the creative nature of the individual rather than creativity within a particular time, and (5) was not related by any means to usage of IS, or other types of computer technology.

Along with the suggestions of Berman and Parker (2002), we included only one set of results from a single study, even if multiple publications based on the same data were available. It is important to note that once the studies have been located and evaluated, investigators are reluctant to neglect any information without performing additional analyses on outcomes (Berman and Parker, 2002). Therefore we did not exclude any studies that satisfied the raised criteria.

3.4 Measurements

Because meta-analysis focuses on the aggregation and comparison of the findings of different research studies, it is necessary that those findings be of a sort that can be meaningfully compared, that is (a) deal with the same constructs and relationships and (b) be configured in similar statistical forms (Lipsey and Wilson, 2001, p2).

Meta-analysis represents each study's findings in the form of effect sizes, which is a statistic that encodes the critical quantitative information from each relevant study finding (Lipsey and Wilson, 2001, p3). Quantitative findings take many different forms, and may appear as differences between group means, correlations between variables, and the proportion of observation in a particular category (Lipsey and Wilson, 2001, p12). Each of the preceding forms of research findings can usually be meta-analyzed in a straightforward way using one of the established effect size statistics (Lipsey and Wilson, 2001, p15). Additionally, to aforementioned forms, regression coefficients was proven to be a valid form of the effect size (Peterson and Brown, 2005). From the studies that we've included into the analysis phase, we used one of these three types of summary statistics—correlation, differences between group means, and regression coefficients.

The majority of the findings of our analysis were found in correlation tables. According to Lipsey and Wilson (2001, p.15), meta-analysis of research findings on the association or correlation between two variables of interest is common. A study may report the correlation matrix, upon which multiple regression is based, and selected bivariate correlation from that matrix could then be used as effect sizes (Lipsey and Wilson, 2001, p.15). While effect sizes were directly observed from a provided correlation table, effect sizes from other statistics needed to be calculated. Size effects of differences in group means were calculated from experimental data with a formula (1) based on Lipsey and Wilson (2001, p.198), and regression's beta coefficient converted to correlation based on Peterson and Brown (2005) with the formula (2).

$$(1)\, ES_{sm} = \frac{\overline{X_1} - \overline{X_2}}{s_{pooled}} \text{ and } s_{pooled} = \sqrt{\frac{(n-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}},$$

where $\overline{X_1}$ and $\overline{X_2}$ refer to treatment and control groups' means, s_1 and s_2 to standard deviations, and n_1 and n_2 to sample sizes of both groups

$$(2)\, r = .98\beta + .05\lambda,$$

where r refers to size effect, β – regression coefficient, and λ - indicator variable that equals 1 when β is nonnegative and 0 when β is negative.

The aim of gathering relevant studies was to fill in a correlation matrix with variables that were identified in our model. This is the main condition in order to use meta-analytical regression (Viswesvaran and Ones, 1995). A more explicit view of variables can be found in Appendix A.

3.5 HOMA procedure

In the next step, size effects were analyzed using a Hedges and Olkin-type meta-analysis (HOMA, Hedges and Olkin, 1985). HOMA refers to a set of statistical procedures developed and codified by Hedges and Olkin (1985) for calculating the meta-analytic mean correlation for a theorized relationship between variables and for assessing the significance of the relationship through the computation of corresponding confidence intervals (Lipsey and Wilson, 2001). In practice, HOMA makes use of effect sizes such as the Pearson product-moment correlation r or the partial correlation coefficient $r_{xy.z}$ as the data in the analysis (Essen et al., 2015). A product-moment correlation was employed in this research. r was used because it offers a scale-free measure of linear association. All correlation coefficients were transformed to a Fisher's Z_r-transformation to correct for skewness in the effect-size distribution (Hedges and Olkin, 1985). Such normalizing transformation was done as meta-analytic methods assume that the sampling distribution of the observed outcomes is normal.

Some effect sizes are more precise than others, as some of them are built on a higher amount of responses than others. To account for differences in precision across effect sizes, effect sizes were weighted according to their standard errors (Hedges and Olkin, 1985).

3.6 MASEM procedure

While conventional meta-analysis is well acknowledged in social sciences, meta-analytical structural equation modeling is just entering the field of social sciences (Christian et al., 2009; Earnest et al., 2011; Essen et al., 2015) and is completely new in the IS area. If the researchers are only interested in the effect sizes, conventional meta-analysis is sufficient. However, researchers might be interested in testing the mediation and moderation models on the effect sizes (Cheung, 2015, p.2). In this case, the meta-analytic structural equation modeling (MASEM) can be used. MASEM is an extension of conventional meta-analysis. Firstly, meta-analysis is used to pool correlation matrices together in stage 1 analysis, so called HOMA. Later, the pooled correlation matrix is used to fit structural equation models (SEM) in the stage 2 analysis (Cheung, 2015, p.4).

SEM is a popular statistical technique to test hypothesized models in the social, educational, and behavioral sciences. SEM is popular in applied research due to the fact that theoretical models can be translated into a set of interrelated equations involving latent and observed variables. It is acknowledged that SEM is a flexible modeling technique to test proposed models, which can be specified as path diagrams, equations, or matrices (Cheung, 2015, p.2). In other words, SEM permits hypotheses derived from theory to be tested.

There are several steps involved in fitting a structural equation model (Kline, 2011). Initially, a proposed model is specified based on the hypothesized relationship among the observed and latent variables. The proposed model is fitted against the data, and users may determine whether the proposed model fits the data well. In case it does not fit the data, users may modify the model to see if model fit can be improved.

Most of the SEM applications are based on primary data. This leads to some SEM application issues. For instance, even when studying a set of similar constructs, different researchers may propose different models that are supported by their own data, which could be difficult to systematically compare and synthesize (Cheung, 2015, p.215). As long as proposed models are consistent with the researchers' theories and supported by the data, most researchers may not consider the need to test and compare alternative models (MacCallum and Austin, 2000). Another issue is related to the nature of SEM itself. It has been recognized that the statistical power of the SEM in rejecting incorrect models may not be high enough when the sample sizes are small (Cheung, 2015, p.215). However, conducting more empirical research does not necessarily decrease the uncertainty surrounding a particular topic if the findings from that research are inconsistent (Cheung, 2015, p.215).

Viswesvaran and Ones (1995) suggest that MASEM can be built on a set of studies, which have reported correlations between two variables (A and B), combining the results with another set of studies, which have reported the relationship between variables B and C. Yet another set of studies may have reported correlations between A and D, B and D, and C and D, respectively. The usefulness of the MASEM methodology inherently builds on its ability to combine and examine the interrelationships among these findings even though no single study reported correlations between all of the variables. Meta-analysis therefore uses the estimates of the true correlations for input into structural equation modeling. MASEM gives an opportunity to test a structural model not tested in any primary study (Landis, 2013). This enables researchers to test proposed models across various samples, conditions, and measurements. If there are a handful of primary studies conducted by different researchers, it is likely that different samples and measurements were used. If the proposed model still fits the data well across studies, this provides strong evidence of the validity of the proposed models. If the proposed models do not fit the data, the studies may be grouped according to the study characteristics, such as samples and measurements. The study characteristics may be used to explain the differences in the findings that different models fit the data. Results on a meta-analysis may provide more useful information than a single study with a large sample (Cheung, 2015, p.216). This case can be explained through the Murayama and Elliot (2012) study. Researchers conducted a meta-analysis on the association between competition and performance. They found that the average correlation between these two constructs was close to zero. While theoretically it was difficult to explain this effect, by incorporating two mediators and testing the model with MASEM, authors found that the specific indirect effects were in opposite directions and significant as predicted by hypotheses.

There are some issues that need to be considered in order to perform MASEM properly. A clear conceptual foundation plays an important role in validating the results. As suggested by Landis (2013), MASEM should be used for testing the model rather than for developing a model on analysis results. To satisfy this criteria, the meta-analysis method was employed to test the hypotheses in this study. The main rationale driving the choice of this method was the high number of creativity-related papers.

MASEM was used in this study to discover whether there is a presumed mediation between independent and dependent variables. Baron and Kenny (1986) proposed three criteria to test mediation. The first criterion is that the independent variables must account significantly for the variations in the presumed mediators. Second, the mediators must affect the dependent variable. Third, the independent variable must be shown to affect the dependent variable.

If all of these conditions hold in the predicted direction, mediation occurs when the effect of the independent variable on the dependent variable reduces when the mediators are added to the model. Additionally, Zhao et al. (2010) suggests that in order to establish mediation, the main aim is to show that the indirect effect is significant. Tests using a MASEM approach were performed, and the results were evaluated by following structural equation modeling routines. Taken into consideration, the overall data fit to the model by *Chi-square* and RMSEA measures. MASEM was performed by using a software package designed for R statistics and called “metaSEM”.

4 RESULTS

4.1 HOMA results

The appendix shows obtained results from each study including the effect size (r), and sample sizes (N). Table X shows the results of primary syntheses for each relation among variables included in the model. It includes studies that were combined for the analysis (k), total sample size (N) random-effects weighted mean observed correlation (r_{re}), confidence interval (CI), results of homogeneity test (Q), and level of heterogeneity (I^2). Interpretation of I^2 was made based on guidelines adopted from the *Cochrane Handbook* (Higgins and Green, 2008). I^2 less than 40% might not indicate heterogeneity, but from 30% to 60% may represent moderate heterogeneity, from 50% to 90% may represent substantial heterogeneity, and from 75% to 100% considerable heterogeneity.

Three variables that were included into Hypothesis 1 and relations among them were examined. Mean effect size showed that a challenging task does not have a strong relationship with creativity (r_{re} = .09). However, effect sizes of studies included in this calculation vary from -0.1417 to 0.3159, and in accordance with the homogeneity test, which is significant, shows high heterogeneity (I^2 = 98%). These results indicate that there are moderators and mediators that shape this relation. One of these variables might be the perceived flow experience, as results show a strong significant link of this variable with a challenging task (r_{re} = .49; 95% CI: .35 to .63), and indicate moderate heterogeneity (I^2 = 59%) with non-significant homogeneity test (p=0.06). Flow and creativity mean effect size calculated based on four studies was large (r_{re} = .63), and significant (95% CI: -.02 to .43) as well. Although results indicate strong correlation, the homogeneity test was significant, showing high heterogeneity (I^2 = 98%), suggesting that there might be still unidentified variables in this relation.

Due to a lack of studies, a heterogeneity test was not performed on any of the relations from Hypothesis 2.

When testing our hypothesis 3, we were interested in the relationship between flow and cognitive load. However, the findings do not support the hypothesis, but indicate a weak (r_{re} = -.07) link with spread confidence interval, and rather high heterogeneity—I^2 =94%, CI = -.2534 to .3908.

Results from the examination of other relationships among the variables, which were not included into hypothesized models, and which can be found in Appendix D, did not indicate the existence of another chain effect. Only one relation correlated moderately—ease of use and flow (r_{re} = .33), but confidence interval was large (95% CI: -.12 to .78). Other mean effect sizes did not indicate correlation. The link between challenging task and cognitive load is rather weak (r_{re} = -.09). Both relations were highly heterogeneous with spread confidence intervals of I^2 = 98%, CI = -.12 to .78; and I^2 =94%, CI = -.4773 to .2958, respectively.

Additionally, three relations had only one study, based on which calculations were made. Therefore, the heterogeneity test did not apply to them, and we will describe only effect sizes. Mean effect size between cognitive load and creativity is small (r_{re} = .14). Ease of use and cognitive load relation (r_{re} = -.30), similar to ease of use and creativity relation, which had moderate negative size effect (r_{re} = -.30).

A homogeneity test was done for all relations that have more than one study in order to choose between a fixed-effect model and a random-effect model in further analysis. A fixed-effect model is used to analyze size effects that were homogeneous, i.e., measurement of variables using the same scales, and where the strength of effect varies only due to sampling. Meanwhile, a random effect model is used to analyze heterogeneous relationships, i.e., size effects that vary not because of a sample size, but due to measurements, and of the presence of another variable affecting the strength of the relationship. Considering the results of the homogeneity test, the majority of the links are heterogeneous. Therefore, in the next part the random effect model will be used.

Table 2 Analysis of the links among the variables

Correlations between variables		k	N	r_{re}	95% CI	Q	I^2
Cognitive load (CL)	Creative performance (CP)	1	90	0.143	[-0.0605; 0.3465]	-	-
Task-related challenges (TRC)	Creative performance (CP)	6	14296	0.0871	[-0.1417; 0.3159]	276.9697 (p<0.0001)	98.19
Flow experience (FE)	Creative performance (CP)	4	1138	0.627	[0.4284; 0.8256]	141.0381 (p<0.0001)	97.87
Ease of use (EOU)	Cognitive load (CL)	1	24	-0.309	[-0.6787; 0.0607]	-	-
Ease of use (EOU)	Creative performance (CP)	1	90	-0.297	[-0.4864; -0.1076]	-	-
Task-related challenges (TRC)	Flow experience (FE)	4	289	0.4864	[0.347; 0.6259]	7.3255 (p=0.0622)	59.05
Flow experience (FE)	Cognitive load (CL)	5	584	0.0687	[-0.2534; 0.3908]	66.9254 (p<0.0001)	94.02

Table 2 summarizes our analysis of the links among the variables, as investigated in the HOMA procedure.

4.2 MASEM results

As discussed previously, the results concentrate on finding possible mediation effects. To achieve this, four models were tested in order to define whether there was a mediation effect and whether the proposed hypotheses were significant. Model 1 tested the hypotheses based on the theory of flow. First, we tested the fully mediated model. Second, we tested the model that has partial mediation. That is, the model that incorporates a direct link between task-related challenges and creativity, and a mediated link between these two variables. Model 2 tested the hypotheses related to cognitive load theory. Respectively, it included the test for the fully mediated conceptual model, and the model with partial mediation on Hypothesis 2. In addition, Model 3 incorporated Hypotheses 3 and 2. Hypothesis 3 was tested with the fully mediated model, and subsequently, the model incorporated Hypothesis 2 for a test of a partial mediation. Finally, we tested the direct effect in Model 4 without any mediation.

Model significance was tested by the Chi-square and its p-value; however, when the sample size is high, a Chi-square might show signs of significance due to a large sample. To avoid this error, an additional RMSEA measure and CFI were also used. The RMSEA measure was interpreted based on guidelines borrowed from MacCallum et al. (1996), where RMSEA scores of 0.01, 0.05, and 0.08 indicate excellent, good, and mediocre fit, respectively. CFI was interpreted as follows—higher than 0.9 indicates good data fit. In the next stage, to see which of the significant models fits data better, AIC and LBCI measures were used.

Results presented in Table 3 show support for the fully mediated model (H1a+H1b and H2a+H2b). RMSEA measures were decent for all tested models. Chi-square and p-value, on the other hand, varied. These measures show high significance ($p<0.05$) for cases in Models 3 and 4. Additionally, in the Model 1 some of the effects were close to significant ($p<0.07$) at 95% confidence level, and fully mediated in the Model 2. As the results varied, a comparison of the models based on how they fit the data by the AIC measure was used. Smaller AIC values show better model fit, and thus it is more favorable than higher ones. AIC values of the models supported by the significance tests vary from 0.051 to 61.162, where our hypothesized Model 2 has the lowest score. While partially mediated Model 2 has the absolute lowest AIC score, the significance test is rather high, and lower and upper LBCI scores of direct effect have high difference. Due to these reasons we rejected this model. For models testing Hypothesis 3, p-value and RMSEA scores were decent, however, the CFI score was rather low, and AIC was high. Additionally, partial mediation does not change direct effect drastically from [-0.490, -0.300, -0.110] to [-0.495, -0.312, -0.131], which can indicate no mediation.

Table 3 MASEM model testing (N=18315)

	Chi-square	DF	p-value	RMSEA	CFI	AIC	Direct effect (H1)	Direct effect (H2)
Model 1 (Theory of flow)								
H1a+H1b and H2a + H2b	12.05	6	0.0608	0.0074	0.954	0.051	[0.168 0.246 0.337]	[-0.255 -0.117 -0.018]
H1+H1a+H1b and H2a+H2b	10.4357	5	0.0638	0.0077	0.9583	0.4357	[-0.181 0.084 0.348]	[-0.255 -0.117 -0.018]
Model 2 (Cognitive load theory)								
H2a+H2b and H1a+H1b	12.05	6	0.0608	0.0074	0.954	0.051	[0.168 0.246 0.337]	[-0.255 -0.117 -0.018]
H2+H2a+H2b and H1a+H1b	6.8945	5	0.2286	0.0045	0.9855	-3.1055	[0.168 0.246 0.337]	[-0.487 -0.297 -0.107]
Model 3 (Cognitive load and Flow)								
H3	75.16	7	0	0.0231	0.4769	61.162	-	[-0.091 -0.023 0.0162]
H3+H2	64.92	6	0	0.0232	0.5478	52.920	-	[-0.495 -0.312 -0.131]
Model 4 (Direct effect)								
H1 and H2	130.28	8	0	0.0289	0.062	114.2805	[-0.181 0.084 0.349]	[-0.490 -0.300 -0.110]

As described in Table 3, the results support model fully mediated Hypotheses 1 and 2 based models, however not the Hypothesis 3. More precise, results do not show great significance for hypothesized cognitive load impact on flow experience in the model. However, it do show support for the model build from Hypothesis 1 and 2, i.e. full mediation between challenge related task and creativity, as well as ease of use and creativity.

5 DISCUSSION AND CONCLUSIONS

Creative work has become an important factor for determining the success of a new product or service. However, previous research on the role of IS in supporting individual users' creative work does not provide a comprehensive explanation on the linkages between IT use and creative performance. Hence, existing research does not provide sufficient support for designing creativity support systems (Voigt et al., 2012). Although creativity is widely researched in the IS research community, information technology is still treated as a black box in this relationship (Seidel et al., 2010). Therefore, this study aims to shed new light on the links between information systems use and the creative performance of individuals. We started this research with the question of how information systems use influences users in their creative process in general. Numerous studies have focused on how to boost individual aspects of creative performance, and we know that advanced use of appropriate technologies can help individuals dramatically in their creative work processes. For example, past research indicates that IS can affect a person's creativity by (1) engaging them in a process, and (2) by equipping them with useful information (Greene, 2002). This work enriches the aforementioned propositions by employing the theory of flow and the cognitive load theory. Using these theories, a conceptual model was proposed to explain how IS facilitates individual users' creative performance. This study designed a model of what has long been suspected, but not empirically tested. What, then, are the implications of our study for researchers and practitioners?

5.1 Theoretical implications

This study enriches the portfolio of IS research methods by applying structural equation modeling (SEM) to a meta-analytical research setting in a key area of IS research: IT users' creative performance. SEM is often associated with the analysis of data samples with primary data, using the covariance matrices as input in the analysis (Jöreskog, 1967). Yet, SEM can be used with meta-analysis results as well. Therefore, the limitation of applying SEM to primary research can be partially addressed by MASEM, a technique combining meta-analysis and SEM for the purpose of synthesizing research findings in studies (Viswesvaran and Ones, 1995). Whereas conventional SEM focuses on primary data, MASEM deals with correlation matrices from a pool of studies (Cheung, 2015, p.215). The usefulness of MASEM has been proven in the areas of psychology (Viswesvaran and Ones, 1995) medical research, and some areas of social sciences.

Moreover, this study extends creativity and IS systems literature by integrating the theory of flow and also cognitive load theory into a conceptual model explaining IS facilitation of individual creativity. Previous studies have stressed the importance of understanding how the IS mechanism assists users in a creative process (Seidel et al., 2010). This research draws on previous propositions and proposes a model explaining this phenomenon. By providing one type of explanation in an area that is lacking, we believe that this model will foster further thinking and result in more research into creativity and IS.

In addition, the findings of this study contribute to the understanding of cognition and its effects on creative performance. The results indicate that cognitive load plays an important role in creativity studies (Avital and Te'eni, 2009). Cognitive fit, which suggests that a system should be adjusted according to the user's past experience, is amplified in creativity literature, but on a general level only (Avital and Te'eni, 2009). Thus, in this study we further explored this area. Moreover, cognitive fit explains cognitive load based on the task alignment with user's experience. We, on the other hand, looked into this phenomenon by concentrating not on the skills and knowledge an individual has, but rather on how to extend a user's limits with the system design, e.g., presentation of the information.

Creativity literature identifies the notion that "the aim is to reduce the constraints upon the scientist's explorations and unpredictable courses of action" (Candy and Edmonds, 1995, p.243), and thus create open and dynamic space. More IS-related studies, e.g., Voigt et al. (2012) and Russo and Stolterman (2000), suggest that rich representation—which includes components for simulation, comparison, modification, rich visualization and the like, and additional freedom and flexibility—is a necessity for higher creativity. While, for instance, rich visual and linguistic characteristics or presentation may influence problem understanding (Adams and Avison, 2003), a user who is not familiar with all the features will perceive significant intrinsic load and will not be able to concentrate on the task. By adopting and applying cognitive load theory, this research suggests that information systems for a creative purpose should concentrate on minimizing interruption to users and equip them with the least possible intrusive environment. Such a design will result in higher engagement and better use of the provided information by the tool. This is in alignment with previous literature. For example, representation styles that minimize the cognitive effort needed to understand the requirements for a given task and how to subsequently perform it (Avital and Te'eni, 2009) affect information acquisition (Jarvenpaa, 1989). Computer representation of task-related information reduces the propensity for error, and the time and effort required to complete a task (Vessey and Galletta, 1991).

In addition, this study enriches IS literature in terms of the ease-of-use concept. The study results indicate that *ease of use* does not increase creative performance directly, but rather lowers creativity. This could be explained as individuals possibly perceiving an easy-to-use system as too simple, and feeling more restricted, without enough freedom to engage in a creative performance. Easy-to-use systems lower the individual's cognitive resources needed to understand and use the system, and leaves enough short-term memory resources to concentrate on the creative task itself, and especially to acquire information related to a solution. For example, if the system is not overcrowded with features, but rather designed to support provision of needed information, such as examples, guidelines, and goals, one can better understand and exploit the information in solving a creative problem.

While we hypothesized a relationship between cognitive load and flow experience in the model, we did not find support for their interconnectedness. The relationship of cognitive load and flow still remains rarely explored, and can be utilized to investigate creativity under demanding conditions. Previous studies have only anecdotally looked into the link between these variables, without even clearly establishing the direction and boundaries for the relationship. One way to treat this link in future studies is to investigate the impact of cognitive load on flow (Wang and Tseng, 2014), which we hypothesized. In this sense, augmenting the understanding of the determinants of flow experience could be used in studies concerning IS design. For example, increased ease to use—or simplified rather than complex IS—may ease up information technology use, which may lead to higher engagement with a task in which the technology is used. On the other hand, flow experience can lead to lower cognitive load, increase perceived engagement, and allow for a better concentration and thus allocation of higher memory resources to cope with a task (e.g., Sharek and Wiebe, 2014; Shen and Chu, 2014). Users may subjectively feel that an interactive task is easier to grasp when they are enjoying it (Hinds, 1999). This is consistent with the theory of flow, which suggests that people who are more involved and enjoying what they are doing can focus attention and handle vastly greater amounts of information (Csikszentmihalyi, 1988). This can be amplified by tackling germane cognitive load, which relates to an individual's motivation to learn. For example, Shen and Chu (2014) suggest that a game-based learning system with low joyfulness would produce a higher cognitive load (Shen and Chu, 2014). Additionally, it is shown that germane load is positively associated with the dimensions of flow experience that represents intrinsic user motivation (Shang et al., 2005). Thus, it can be assumed that when users are intrinsically motivated, they report a greater ability to devote cognitive resources to learning, and their performance is improved.

Another implication concerning the theory of flow suggests that when a person's skills and expected challenges are balanced at a reasonable level, the person will become immersed in the activity and lose the presence of time (Mihaly Csikszentmihalyi, 1975). The flow experience has been recognized as an important factor in creativity (Avital and Te'eni, 2009; Csikszentmihalyi and Csikszentmihalyi, 1988). With regards to the theory of flow, this study enriches the literature by indicating that a challenging task affects creativity if the person is immersed in the state of flow. A challenging task by itself does not affect creativity, as has been mentioned in previous works related to flow theory. One explanation for this phenomenon is that an individual first needs to be curious and have a strong interest regarding the problem at hand, and only afterwards can the person immerse into a state of flow, which leads to higher creativity. Therefore, intrinsic motivation might play an important role in fostering users' engagement with a task, which is a prerequisite for the creative process to happen. Such a relationship could be further studied to understand underpinnings.

5.2 Managerial implications

This research suggests some guidelines for designing information systems in order to boost an individual user's creativity. We suggest that systems capable of supporting users' creative performance can be very valuable not only for individual users, but also for an increasing number of companies that compete on the basis of making use of information on their operations. The advanced uses of creativity-supporting systems may contribute to productivity in organizations through, for example, helping R&D personnel in problem solving, enabling knowledge creation in almost all business operations, as well as outside the company in creating insights on how to capture customers' needs. In general, an IS-enabled support for creative work is important in almost all innovation activity.

One of the issues IS designers should consider in fostering creativity and innovativeness is the importance of challenging the user. Our findings indicate that challenges can be twofold; on the one hand, they can foster competition among users, and thus require a quantification of performance and a tracking of scores. For example, socialization features can be implemented in ways that allow a user to receive recognition from other users, and thus create some perceived implicit competition. On the other hand, challenges may lie within the ability of a user to perform a given task through making advanced use of the system rather than through competing with others. These two types of challenges drive designers to deal with various user profiles and backgrounds. Our recommendation for IS designers is to gather user experiences and perceptions of the experienced challenges, and provide the users with alternatives, from simple scenarios toward more advanced uses of the system. In addition, creativity-supporting systems should be able to provide the users with experiences of control and power, as well as the feeling of the completion of tasks through feedback concerning the accomplishments.

Another issue lies in the motivation of the users to perform a task. Based on our analysis of the flow experience, it is necessary to foster and maintain the users' interest in a task. For example, a user's interest and favorable attitude toward the use may be augmented by introducing the task along with a roadmap for completion, or through using scenarios or processes describing the accomplishment. Also, our findings point out that the system should be easy to use, and at the same time have functions that support advanced use. While these two features appear to contradict each other, it is recommended that features be introduced gradually, or according to a user's needs. For example, systems used for information search and knowledge acquisition may support a quick start with a task, but even simple user interfaces may include advanced options for those who are experienced and wish to improve their productivity. Yet, our findings concerning the flow experience indicate that any triggers should be minimized in order to avoid interrupting the users in their activities, and to allow users to stay engaged in the task at hand. Providing practical examples and similar solutions is encouraged in order to initiate a user's creative process and to shape a user's path. This allows users to stay in the process, as otherwise they can become lost if they perceive a task as too complex, or as requiring too much information to proceed. By proposing one way for explaining how technology can affect creativity, we believe it will foster further thinking and research in this area.

5.3 Conclusion, limitations, and avenues for future research

The study explores the effect of information technology on users' creative performance. Based on a review of the existing literature, we link the theories of flow and cognitive load to the analysis of creative performance at the level of individual users of IT. The findings indicate that perceived challenges drive the creative performance of individuals under certain circumstances. In particular, task-related challenges may foster creativity if the user is immersed in the activity. Yet, because the challenges related to an activity are difficult to control in creative work, information technology, which is harnessed to support an individual user's activity in a creative process, has a role in fostering the user's creative performance. Especially, ease of use of an information system drives the system user's creative performance. However, a perceived flow experience has the strongest link with creativity. Hence, information systems should be designed in such a way that they support rather than disrupt flow experience.

This study also has some limitations. The most important is that some of the relationships among variables were based on a small number of previous studies. The limitation pertains to the existing body of knowledge on the topic. We observed the limited amount of data available, as there exists only few studies on this topic, and researchers examined a limited set of factors. Hence, some relationships among variables had only one or two studies, on which effect size was estimated.

There is also a set of limitations that comes from the nature of meta-analysis itself. In meta-analysis, researchers should be particularly concerned with publication bias, i.e., the effect of failing to detect unpublished trials, which mostly comes from not publishing research due to non-significant or uninteresting results. A more detailed explanation of publication bias can be found in a study by Banks et al. (2012). Another issue in meta-analytical research is the difficulty of comparing studies based on different qualities, contextual characteristics, and summary statistics. More explanation regarding criticisms of meta-analysis and steps to tackle them can be found in an article by Rosenthal and DiMatteo (2001).

In general, MASEM is based on the summary statistics, and the raw data are usually not available, whereby techniques involving raw data are generally not feasible in the meta-analytical approach. If there are problematic data, such as missing data and non-normal data in the primary studies, it is hard to correct them in MASEM. Additionally, we were not able to access a handful research articles on the topic published in "small group research" journals, which we found in the references lists of the reviewed articles.

Given the aforementioned limitations, our findings should be interpreted with caution. However, these limitations provide interesting avenues for further research. Some aspects of the ways IS use will affect users' cognition have been addressed in the emerging literature on neuro-information-systems (NeuroIS), including cognitive neuroscience and neuroeconomics (cf. Riedl and Léger, 2016). To advance the development of this knowledge base, we call for more empirical research to deepen our understanding of the direct and indirect effects of system design and the essential contingency factors on individual users' creative performance, which remains one of the issues of perennial interest in information systems research.

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Appendix A: Measurements

As suggested by Landis (2013), preconditions should be considered in order to allow for a thorough literature review. One of these preconditions is a clear definition of the primary constructs, and avoidance of assumptions that constructs using the same names describe the same phenomenon. Such thinking allows one to locate relevant studies and to draw meaningful inferences from results. Therefore, in this section we will describe measurements of each of the constructs to ensure trustworthiness of the analysis.

Despite the different disciplines taken into consideration in order to answer a research question, all the used variables were measured according to a similar pattern. Creativity was measured in two ways: (1) quantitative—counting the number of novel ideas and experiment subjects developed for a given task, and/or (2) qualitative—involving experts for experiments or supervisors for surveys to evaluate creative performance, or individual self-report. Studies could be divided into three types—self-reports, external person assessments, and objectively measuring output. There were no clear patterns in the items used, only Zhou and George (2001) developed items that were used twice.

Not all the studies clearly stated that a flow experience variable is a point of interest. However, all of them defined it according to the description of flow, and cited theories of flow. The concept of flow overall was treated ambiguously. On the one hand it is called in terms of absorption, involvement, and engagement, and on the other hand some developed measurements of flow might not measure this concept effectively. This pattern was found in one study (Debue and van de Leemput, 2014), which we dismissed from further analysis.

Cognitive load was measured in two ways. Researchers that had a cognitive load variable predefined it based on assumptions and theoretical discussion. For example, the particular system used in the experiments created either a high or low cognitive load, and the results of usage of one system were compared with another. Hender and Dean (2002) measured ease of use to evaluate cognitive load for various tools, but the correlation among different cognitive load tools was too weak (between -0.121 and -0.297) to accept ease-of-use as a construct of cognitive load. The results suggest that cognitive load might be a mediator between ease of use and another variable. Another way was to ask subjects about the mental effort that a task required. However, there was no one particular scale established to measure this variable.

The measurements concerning ease of use, however, were more or less the same for all cases. Only one study developed items to measure ease of use, and other studies used measurements developed by Davis (1989), or cited studies that reused these measurements in further work. In the analyzed studies, the variable for describing a challenging task was described in a couple of ways. Some studies described it as an intellectually challenging environment, and it was either predefined by authors as different tasks for an experiment, or was examined through a survey. Some studies used job complexity to describe a variable responsible for accounting for effort needed to complete a job, and measured it by asking managers to rate the job conditions. Despite different names, the variables measured the same phenomena—challenges for individuals.

Table 1. Studies used in the meta-analysis with employed variables and items

Study	Items Adopted From	Method
Creativity		
Amabile (1996)	Amabile and Gryskiewicz (1987)	Self-report
Elie-Dit-Cosaque and Pallud (2012)	Undefined	Self-report
Jung et al. (2005)	---	Expert assessment
Hender and Dean (2002)	---	Expert assessment
Shalley and Perry-Smith (2001)	Amabile (1983)	Expert assessment
Shalley et al. (2009)	Oldham and Cummings (1996)	Self-report
Wood et al. (1994)	---	Amount of generated ideas
Xiaoxia and Fangxiang (2013)	Zhou and George (2001)	Supervisor assessment
Zhang and Bartol (2010)	Zhou and George (2001)	Supervisor assessment
Zheng and Kim (2007)	Scott (1965)	Self-report
Flow experience		
Elie-Dit-Cosaque and Pallud (2012)	Agarwal and Karahanna (2000)	Self-report
Ghani et al. (1991)	Ghani (1991)	Self-report
Ghani and Deshpande (1994)	---	Self-report
Hsu and Lu (2004)	Novak et al. (2000)	Self-report
Huang et al. (2013)	---	Self-report (measured as game involvement)
Lai et al. (2012)	Pearce et al. (2005)	Self-report (measured as game involvement)
Lowry et al. (2013)	Agarwal and Karahanna (2000)	Self-report (measured as game immersion)
Rosen and Kluemper (2008)	Hsu and Lu (2004)	Self-report
Schrader and Bastiaens (2012)	Witmer and Singer (1998)	Self-report (measured as immersion)
Stibe and Oinas-Kukkonen (2014)	---	Binary variable (measured as engagement)

Webster and Ahuja (2006)	Webster and Ho (1997)	Self-report (measured as engagement)
Xiaoxia and Fangxiang (2013)	Zhang and Bartol (2010)	Self-report (measured as creative process engagement)
Zhang and Bartol (2010)	---	Self-report (measured as creative process engagement)
Zheng and Kim (2007)	Kyle et al. (2004)	Self-report (measured as involvement)

Cognitive load		
Basoglu et al. (2009)	Eveland and Dunwoody (2000)	Self-report
Dang et al. (2012)	---	Predefined choice
Hender and Dean (2002)	---	Predefined choice
Huang et al. (2013)	Keller (1987)	Self-report
Lai et al. (2012)	Unidentified	Self-report
Schrader and Bastiaens (2012)	Paas and Van Merriënboer (1994) and Kalyuga and Paas (2005)	Self-report
Sharek and Wiebe (2014)	Wiebe et al. (2010)	Self-report
Webster and Ahuja (2006)	Ahuja and Webster (2001)	Self-report

Ease of use		
Dang et al. (2012)	Davis (1989)	Self-report
Hender & Dean (2002)	Sambamurthy and Chin (1994)	Self-report
Hsu & Lu (2004)	Davis (1989)	Self-report
Lowry et al. (2013)	Agarwal and Karahanna (2000) and Venkatesh (2000)	Self-report
Mathieson and Keil (1998)	---	Self-report
Rosen and Kluemper (2008)	Davis (1989)	Self-report

Challenging task		
Amabile (1996)	Amabile and Gryskiewicz (1987)	Self-report
Basoglu et al. (2009)	---	Predefined choice
Ghani et al. (1991)	Csikszentmihalyi and Csikszentmihalyi (1988)	Self-report
Ghani and Deshpande (1994)	---	Self-report
Jung et al. (2005)	---	Predefined choice
Mathieson and Keil (1998)	---	Self-report
Shalley and Perry-Smith (2001)	---	Predefined choice
Shalley et al. (2009)	Roos and Treiman (1980)	Job context was coded
Sharek and Wiebe (2014)	---	Predefined choice
Stibe and Oinas-Kukkonen (2014)	---	Predefined choice
Wood et al. (1994)	---	Predefined choice

--- : items were developed in the study

Appendix B

CODING FORM FOR META-ANALYSIS

General Information

1. Study ID number (STUDYID)
2. Type of Publication (PUBTYPE)

a. Top IS journal
b. Other IS journal
c. Other TOP journal
d. Other Journal
e. IS conference paper

3. Publication year (PUBYEAR)

Variable Codification: Level One (LEVEL1)

	1.	2.	3.	4.	5.
1. Challenging task	-				
2. Ease of use	1	-			
3. Flow experience	4	3	-		
4. Cognitive load	2	1	5	-	
5. Creativity	6	1	4	1	-

The number indicates how many studies were discovered in the literature between these two variables.

1. Independent variable (VARCAT)
2. Scale type of independent variable (INDSCA)

Continuous
Dichotomous
Continuous Proportion
Likert
Scale

3. Dependent Variable (OUTCOME)
4. Scale type of dependent variable (INDSCA)

Continuous
Dichotomous
Continuous Proportion
Likert
Scale

Variable Codification: Level Two (LEVEL 1 - LEVEL 2) - VARCAT

1. Challenging task
2. Ease of use
3. Flow experience
4. Cognitive load
5. Creativity

Respondents

1. Students
2. Military
3. Non-creative job employees
4. Creative job employees
5. Mixed job employees
6. Managers.
7. Mixed
8. Schoolchildren

Effect Size Information

1. Page number where the effect size was found (PAGENUM)
2. Sample Size (N)
3. Correlation coefficient (COR)

Appendix C

Coding Results

STUDYID	PUB-YEAR	PUBTYPE	VARCAT	INDSCA	OUT-COME	DEPSCA	PAGE-NUM	N	COR	RESPON-DENTS
Cognitive load		**Creativity**								
Hender	2002	a	4	c	1	e	75	90	0.143	1
Challenging task		**Creativity**								
Amabile	1996	c	6	d	1	d	1164	12525	0.485	5
Jung	2005	c	1	c	5	a	890	102	-0.421	1
Jung	2005	c	1	c	5	a	890	102	0.366	1
Shalley	2001	c	6	d	1	d	14	54	-0.268	1
Shalley	2009	c	6	d	1	d	498	1465	0.2	7
Wood	1994	c	1	c	5	a	195	48	0.079	1
Flow		**Creativity**								
Cosaque	2012	c	3	d	5	d	6	188	0.307	7
Xiaoxia	2013	c	3	d	5	d	695	398	0.524	4
Zhang	2010	c	7	d	1	d	116	367	0.7	4
Zheng	2007	c	3	d	5	d	9	185	0.58	7
Ease of use		**Flow**								
Hsu	2004	b	5	d	7	d	865	233	0.228	7
Lowry	2013	b	2	d	3	d	631	455	0.695	1
Rosen	2008	c	2	d	3	d	6	522	0.059	1
Ease of use		**Cognitive load**								
Dang	2012	a	5	d	4	b	116	24	-0.309	1
Challenging task		**Ease of use**								
Mathieson	1998	b	6	d	5	d	226	271	-0.025	1
Ease of use		**Creativity**								
Hender	2002	a	5	d	1	e	75	90	-0.297	1

Challenging task		**Flow**								
Ghani	1991	c	1	d	3	d	232	59	0.457	1
Ghani	1994	c	6	d	8	d	386	63	0.51	6
Ghani	1994	c	6	d	8	d	386	66	0.28	6
Stibe	2014	c	1	d	3	d	10	101	0.618	1
Challenging task		**Cognitive load**								
Basoglu	2009	d	1	b	4	d	186	257	-0.284	1
Sharek	2014	d	1	b	4	d	581	156	0.11	7
Flow		**Cognitive load**								
Huang	2013	d	3	d	4	d	65	264	0.147	1
Lai	2012	f	3	d	4	d	280	49	0.456	8
Lai	2012	f	3	d	4	d	280	49	0.143	8
Schrader	2012	b	3	b	4	d	654	84	0.079	8
Webster	2006	a	3	d	4	d	678	138	-0.45	1

Appendix D

Full correlation table

Correlations between variables		k	N	r_{re}	95% CI	Q	I^2
Cognitive load (CL)	Creative performance (CP)	1	90	0.143	[-0.0605; 0.3465]	-	-
Task-related challenges (TRC)	Creative performance (CP)	6	14296	0.0871	[-0.1417; 0.3159]	276.9697 ($p<0.0001$)	98.19
Flow experience (FE)	Creative performance (CP)	4	1138	0.627	[0.4284; 0.8256]	141.0381 ($p<0.0001$)	97.87
Ease of use (EOU)	Flow experience (FE)	3	1210	0.3287	[-0.1201; 0.7775]	185.2221 ($p<0.0001$)	98.92
Ease of use (EOU)	Cognitive load (CL)	1	24	-0.309	[-0.6787; 0.0607]	-	-
Ease of use (EOU)	Creative performance (CP)	1	90	-0.297	[-0.4864; -0.1076]	-	-
Task-related challenges (TRC)	Flow experience (FE)	4	289	0.4864	[0.347; 0.6259]	7.3255 ($p=0.0622$)	59.05
Task-related challenges (TRC)	Cognitive load (CL)	2	413	-0.0907	[-0.4773; 0.2958]	16.2203 ($p<0.0001$)	93.83
Flow experience (FE)	Cognitive load (CL)	5	584	0.0687	[-0.2534; 0.3908]	66.9254 ($p<0.0001$)	94.02
Task-related challenges (TRC)	Ease of Use (EOU)	1	271	-0.0247	[-0.1439; 0.0945]	-	-